Pan-European policy experimentations with tablets
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# D2.1 LITERATURE REVIEW
# EVIDENCE OF IMPACT OF 1:1 ACCESS TO TABLET COMPUTERS IN THE CLASSROOM

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# Table of contents

# 1. THE BRIEF

*The following literature review is carried out as part of the two year Creative Classrooms Lab project (April 2013-March 2015), which runs a pan-European policy experimentation on the use of tablets in secondary schools in 45 classrooms in 8 countries. The aim of the literature review is to identify and document results of published 1:1 studies related to a number of key themes, such as the innovative and creative pedagogical use of tablets for collaborative learning, active learning, personalisation, engagement and assessment. Next to pedagogical issues the literature review also aims to identify during the two years of the project evidence related to the successful implementation of 1:1 tablet initiatives in schools such as 1:1 classroom management, funding and incentive policies, teacher professional development activities, availability of learning resources/apps, change management processes linked to tablet implementations and policy challenges related to up scaling and mainstreaming tablet experimentations.*

This work informs the pedagogical scenario development process in WP2 and the first mainstreaming/capacity development workshop in WP6. Monitoring of studies will continue until the end of the project in M24, when an updated version of the literature review will be provided.

This first version of the literature review concentrates on identifying evidence related to the key themes and priorities identified by policy makers in the beginning of the project. The idea is to establish an evidence base around the core topics of the pedagogical scenarios, which will be implemented by teachers in all countries during the first set of pilots to be run from November 2013 until April 2014. The core topics identified are:

- Personalisation: e.g. where the project explores how technology-based learning resources can be organised and modified to overcome learning barriers for individual learners and maximise their learning outcomes
- Content creation: e.g. where the project explores how teachers and learners have migrated from consumers of content to creators, including apps, multi-media and other formats
- Flipped Classroom: e.g. where direct instruction is delivered outside the group learning space/classroom and teachers then use in-class time to actively engage students in the learning process and provide them with personalised support. This approach can be a powerful element of a Personalisation strategy (see above)
- Collaborative Work: e.g. where the project explores how collaborative learning involves two or more people co-operating in a learning experience to share and contribute to each member's understanding of a topic and to complete a given task
- Assessment: e.g. where the project explores how teachers and learners can generate and receive feedback on their progress through the means of technology

Next to these issues identified by policy makers, the literature review looks in the first section at evidence on how to make the best use of tablets, and identifies emerging evidence on other topics in the last section.

NB: Other topics will be researched and integrated in the literature review as the project evolves.

# 2. THE RESEARCH BASE

The introduction of 1:1 access to tablet computers is a relatively recent phenomenon with the first full-scale implementations in UK schools such as Longfield Academy and Honywood School taking place in the autumn term of 2011. The literature review has therefore revealed a fairly limited range of academic research but from a wide geographical area including Australia, New Zealand and the USA.

Evidence comes in three broad categories; rigorous, usually academic, research data; observational/anecdotal information; and advice, often in the form of blogs. The latter two categories were taken into the picture as the rigorous research on the use of tablets in schools is currently not widely documented yet. Research carried out into the projected take-up of 1:1 access to tablets and apps in English schools by BESA, the UK trade body for suppliers into the education sector, identified two major concerns from teachers: the cost, and the lack of evidence on their impact in the classroom (BESA, May 2012). This literature review, and the CCL project itself, therefore seek to provide more insights on how tablets can be efficiently exploited in the education process.

Although there is relatively little academic research on the use of tablet computers in education, the exceptions include the work by Burden in Scotland (2012), Clarke and Svanaes in the UK (2012), and Heinrich at Longfield School (2012). There is however a lot of observational and anecdotal evidence on the impact of tablet technologies on engagement, concentration, motivation, behaviour, self-directed learning and collaborative behaviour which is of interest, even though it does not always fall within any of the above pilot themes. Examples include the study on Android Tablet Use in the 5$^{th}$ Grade by Bjerede & Bondi (2012) and case studies written by schools on their experience such as Wildern School in the UK (Freedman, 2012).

There is also evidence that the impact can vary between boys and girls, as observed in the University of West Scotland research in Cedars School of Excellence in Scotland, involving two classrooms of 8-11 years old pupils (Marks, et al, 2012).

Finally, several iPad programmes have been run with very young children, including pre-school age. One study video-taped 41 3-6 year olds, with positive results on engagement, literacy, and expression of ideas through drawing with a stylus pen (Couse & Chen, 2010).

# 3. Introduction to the Concepts Of Innovation and Creativity

Most people agree that "schools need to develop creativity in students" (Kärkkäinen & Stéphan, 2013) and emphasis put on innovation is today greater than ever also in the education sector (Kärkkäinen, 2012). Moreover, the terms 'innovation' and 'creativity' are mentioned relatively often in the curricula of the EU Member States (Cachia, Ferrari & Punie, 2010) and in most OECD countries, education policies give some place to creativity. Nonetheless, there is no widely used definition of creativity in the educational world (Kärkkäinen & Stéphan, 2013) and many teachers and education experts still feel that the curricula in their countries do not sufficiently encourage creativity and innovation, mainly because it is not clear how the terms should be defined and how they should be treated in learning and assessment. According to Cachia, Ferrari & Punie (2010), there is still little research or evidence on the status, barriers and enablers for creativity and innovation in compulsory schooling at European level. It is the aim of the CCL project to foster the creative and innovative use of tablets in teaching and learning and to contribute to the evidence base in this area.

## Definitions

**Creativity**

It is argued that creativity, in the educational context, should be conceptualized as a transversal and cross-curricular skill, which everyone can develop. Therefore it can be fostered but also inhibited (Cachia, Ferrari & Punie, 2010). Creativity has been defined by Cachia, Ferrari & Punie (2010) as "a process that shows balance of originality and value. It is a skill, an ability to make unforeseen connections and to generate new and appropriate ideas. Creative learning is therefore any learning which involves understanding and new awareness, which allows the learner to go beyond notional acquisition, and focuses on thinking skills. It is based on learner empowerment and centredness."

The terms 'creativity' and 'innovation' are closely interlinked. Creativity is described in European policy documents as a primary source for innovation (Council of the European Union, 2008, 2009a). Innovation is recognised as a process for generating ideas, expressions and forms, in essence as a process that can amplify knowledge and lead to new ways of using knowledge (Council of the European Union, 2009b). The definition Kärkkäinen uses, puts even more emphasis on the outcome of the process, defining innovation as "the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method" (Kärkkäinen, 2012).

Cachia, Ferrari & Punie (2010) define innovation as the application of such a process or product in order to benefit a domain or field- in this case teaching. Therefore innovative teaching is the process leading to creative learning, the implementation of new methods, tools and contents which could benefit learners and their creative potential. "(Cachia, Ferrari & Punie, 2010). Within the context of the SCALE CCR study, the term ICT-enabled innovation for learning refers to profoundly new ways of using and creating information and knowledge made possible by the use of ICT (as opposed to using ICT for sustaining or replicating traditional practices). Such ICT potential for innovation is realised and accompanied by the necessary pedagogical and institutional change (Punie et al., 2011).

The definition of 'innovation' used by the major EU- funded project "iTEC Designing the future classroom" coordinated by EUN is particularly relevant to the CCL project, as the scenarios developed in the Creative Classrooms Lab project are build on the iTEC methodology. The iTEC partners agreed upon the following definition:

Innovation involves "(p)otentially scalable learning activities that provide beneficial pedagogical and technical responses to educational challenges and opportunities." Further, emphasis is put on innovation that has a positive value and reflects an improvement in practice. This definition of innovation incorporates the argument of Michael Fullan (Fullan, 2007) that educational innovation must include the following elements (Ellis, Ayre & Prosser, 2012):

- use of new or revised materials (e.g. curriculum materials or technology)
- use of new teaching approaches (e.g. teaching strategies or activities)
- alteration of beliefs (e.g. pedagogical assumptions)

Finally, it is important to recognise that innovative practice involving ICT in schools varies between countries and "innovation often depends on the cultural, historical or developmental context within which it is observed" (Kozma, 2003). Therefore, what is innovative within one local or national context may be already mainstream in another, and beyond the possibilities of yet another (Ellis, Ayre & Prosser, 2012). Thus, recognising and accounting for the context where the innovation is introduced is critical.

## CREATIVE CLASSROOMS

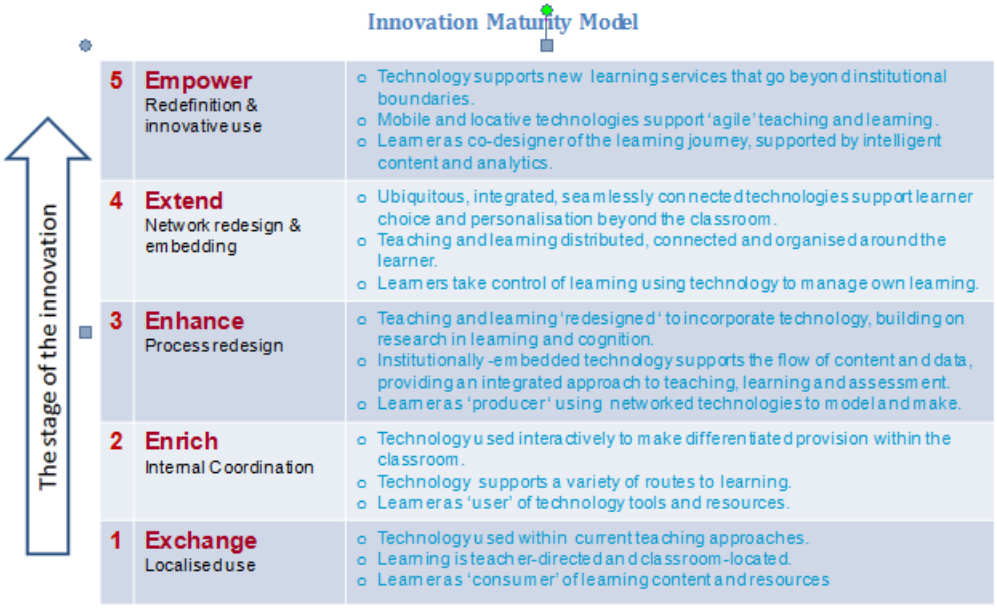
For the CCL project, the term 'creative classroom' is crucial. Bocconi & Punie (2012) describe Creative Classrooms as innovative learning environments that fully embed the potential of ICT to innovate and modernise learning and teaching practices. The focus is on what is possible in today's practices taking advantage of existing and emerging technologies.

- 'creative' refers to innovative practices, such as collaboration, personalisation, active learning and entrepreneurship, fostering creative learning,
- 'classrooms' is considered in its largest sense as including all types of learning environments, in formal and informal settings.

## ROLE OF TECHNOLOGY

Cachia, Ferrari & Punie (2010) highlight the potential of Information and Communication Technologies (ICT) in enabling innovative and creative school environments. Technologies play a crucial role in learners live and can act as a platform to foster creative learning and innovative teaching. Students must be equipped to express their creative and innovative potential through digital media and technologies. Furthermore, ICT provides opportunities for implementing learning approaches that foster creativity. It needs to be emphasized, however, that access to technology alone does not foster innovation, but other factors like assessment, culture, curriculum, individual skills, teaching and learning format need to be considered (Cachica, Ferrari and Punie, 2010). The role of collaboration to foster innovation has been emphasised by Kiira Kärkkäinen and Stéphan Vincent-Lancrin (2013).

The CCL project uses the **Innovation Maturity Model** developed by the iTEC project as a framework to structure the discussion on how ICT can be used in innovative ways at school (Cranmer, 2012). The model shows a number of progressive stages of innovation maturity of an institution, e.g. school. As part of a **self-assessment activity** stakeholders of an organisation's/institution's can identify the organisation's current position on the maturity model. The model was used by policy makers and lead teachers participating in the CCL project to position their school(s) and to decide which level they aim to move to when implementing a specific pedagogical scenario during the first years tablet pilot. The model also serves as a useful tool to evaluate the innovative character of the pedagogical scenarios developed.




**iTEC Innovation Maturity Model**

# 4. EVIDENCE

## 4.1 EXPLORING THE BEST USE OF TABLETS

### WHAT CHANGES WHEN THERE IS 1:1 ACCESS?

Questions of whether every student needs their own device, whether students should be allowed to take them home or whether they should be a shared resource are important given both the financial implications and their potential to improve educational outcomes.

Burden et al (2012), in his review of the iPad in Scotland project, reports that a research project was initiated in 2011 by the Department of Education and Training in Queensland, Australia to identify the suitability of the iPad as a learning tool. The project involved 50 iPads in two schools – a primary and secondary – set in urban and rural contexts. In the primary school iPads were assigned to individual students who were able to take them home. In the secondary school the devices were used as class set shared across three classes and students were not allowed to take them home.

These patterns of ownership and deployment were judged to be significant variables associated with the effectiveness and impact of the project. Although some teachers, such as the teachers from the music department, found the shared model preferable, most identified the personal ownership model as being more effective, not least because it matched the personal nature and design of the device itself which they did not find suitable for multiple logons or users:

*'It is not possible to log onto the iPad as different users, therefore it is a device best suited to a 1-to-1 model. This is particularly the case if personal information, documents, email accounts, calendars and photos need to be stored on the device."* (Department of Education and Training Queensland, 2011)

In the iPad Scotland Evaluation (Burden, et al, 2012) conducted with 365 students between 6-13 years old across eight schools, teachers found that the fact that "everyone had access to a tablet altered the dynamics of their classroom, and enabled a wider range of learning activities". Changes were observed in the way teachers approached their role as educators including:

- more collaboration between teacher and student
- students were encouraged to coach their peers
- students had more freedom to be creative and engage in peer and group assessment
- development and extension of homework with better feedback to students

A general feeling emerged that the students should be trusted more to adopt a sensible approach to accessing appropriate materials, and that central protocols on data security and e-safety could be unhelpful and counter-productive, limiting the benefits of the tablets to the students: According to the study, "(t)he school place(d) considerable trust upon individual students to be responsible users and they (were) allowed to install their own apps and access sites, such as YouTube which are often filtered in other schools. The teacher adopt(ed) a 'hands off' approach to regulation and control although she observe(d) what apps (were) downloaded and students (were) made aware she may check their Internet history (…). Research and the Internet were identified as being

amongst the most important uses of the device changing the dynamics and nature of classroom teaching and learning".

Teachers felt challenged by 24/7 access for students as it required them to get the right balance between complete freedom for learners and the need to provide a framework to guide them. The pedagogical framework for mobile learning (below), (Kearney et al, 2012) provides a useful planning and evaluation tool for teachers when considering their pedagogical practice.

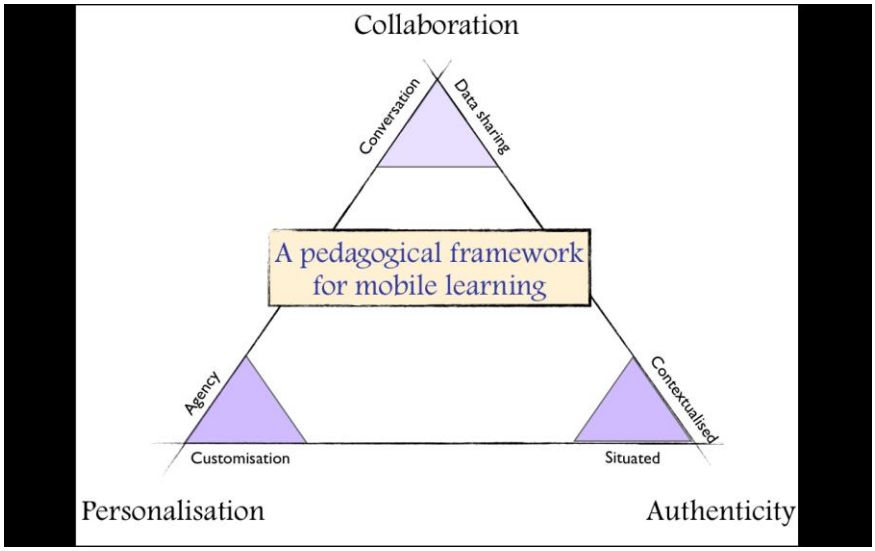



**Figure 1: A framework for mobile learning adapted from Kearney, et al, 2012**

## HOW TABLETS MAKE A DIFFERENCE IN THE CLASSROOM

Burden (2012), who conducted a literature review on the topic, observes that there is a largely unspoken assumption that devices not designed primarily as educational tools will work in an educational context without many problems. Evidence largely supports this as a result of the creativity and imagination applied by teachers and students. Where there are problems in the use of tablets they are often around the fact that they are designed for personal, and not shared or corporate use that provides an element of control over their use.

Burden also questions whether teachers, and the structures within which they operate, are able and willing to accommodate the shift of responsibility for learning from the teacher to the student and their personal learning networks. Tablets raise challenges for teachers, including the need to find the appropriate balance between complete freedom and choice for learners, and the need to provide a framework to guide learners.

Heinrich (2012) talks of learning being "liberated" from the classroom with teachers and students working together to develop individual paths depending on individual student needs.

Research at Longfield Academy (Heinrich et al, 2012) showed that certain subjects favoured the use of the iPads, notably English, Maths and Science. This was partly explained by the availability of suitable apps such as 3D graphing, e-books and Prezi. The iPads were used for a very wide range of activities but the three major areas were:

- researching topics online
- mind mapping
- creation of presentations

Research in nine secondary schools in the North of Italy (Rivotella & Carenzio, 2012) involving 471 questionnaires (teachers, parents & students) and focus groups with students, identifies three main findings:

1. Teachers observed increased student motivation and participation; the paper suggests that increased student participation and collaboration are behind this.
2. Students recognised the value of tablets to take notes and to present their work, while acknowledging that they can also distract them when the teacher is talking.
3. Tablets do not appear to significantly help students to understand concepts, a finding echoed by Stephen Elliott's research at Mounts Bay Academy in the UK. However, they do appear to foster better communications between student and teacher, and between students.

Research published by the National Literacy Trust, a UK based charity that encourages reading and the love of books, reported the following from a survey of 35,000 8-16 years children (National Literacy Trust, 2013):

- 39% read daily from electronic devices while only 28% read printed materials
- 52% prefer to read on screen while only 32% would rather read in print
- Girls are more likely to read in print (68% vs. 54%)
- Those who read daily only on screen are nearly twice less likely to be above average readers than those who read daily in print (15.5% vs. 26%)

In a USA study on Android devices in 5$^{th}$ Grade (Bjerede & Bondi, 2012) involving 27 students (one class) the research found that students quickly established a culture of responsible use of their devices, which seemed to enhance their learning rather than distracting them. Teachers were observed transitioning from primarily preparing and delivering content to the class to an environment where students independently seek out content and contribute it to on-going classroom discussion. The outcome was a culture where the educator and students learned together, and from each other.

One vital condition for this shift was that each student had their own, connected device that was used for personal purposes as well as for classroom learning. The second was that the classroom learning culture supported the students' individual freedom (and responsibility) to explore and experiment, permitting them to decide how to best use the devices to support their learning in the 5th grade. Students chose to use their device in "snippets of time" for maths, spelling, word games, reading, and other educational uses that matched their interest, level, and pace. Essentially, the students eliminated down-time from their day while self-differentiating their learning (Spiers, 2012).

Teachers in the ISATT 2013 study (Roblin et al, 2013) used tablets primarily to support student-centred learning activities by engaging students in the development of knowledge products like mind maps and comics. This study was carried out with 11 teachers in three vocational secondary schools in Flanders. Teachers observed that the tablets facilitated the development of students' competences often ignored in conventional classroom activity including creativity, communication and digital literacy. Limitations of tablets included access issues (hardware and Internet), the alignment of apps with the curriculum, and time necessary to plan lessons to make good use of the devices.Tablet computers, especially those operating in the cloud-based world of Apple, pose a

challenge to schools used to "locking down" computers used by students. Melhuish & Falloon (2010) point out that the cloud presents ethical and moral issues in areas such as data ownership, digital footprints and access to suitable sites and apps. They also identify five specific benefits associated with the use of iPads, although Burden, who includes Melhuish and Falloon's Table in his literature review, points out that this is "a theoretical think-piece not an empirical piece of research".

| Benefits | Pedagogical potential |
|---|---|
| Portability | • Makes technology 'invisible'<br>• Changes where and when learning occurs<br>• Encourages learning in the 3rd Place |
| Affordable and ubiquitous access | • Makes for greater equity and inclusion<br>• Places web access and other digital tools in the hands of more users than any other digital technology |
| Situated | • Enables more constructivist learning using authentic contexts<br>• Enables 'just in time' rather than 'just in case' learning<br>• Blurs boundaries between formal and informal learning |
| Connection and convergence | • Opportunities to 'create, share and connect with others in authentic learning situations |
| Individualised and personalised experiences | • Learning can be tailored to individual needs and preferences |

**Table 2: Pedagogical benefits of iPads (based on Melhuish and Falloon, 2010)**

## Examples of Guidelines for Teachers

The Victorian Government in Australia has developed a dedicated website on using iPads for Learning, providing ideas on how to use the devices across the curriculum, and encouraging teachers to share their experiences and evaluate the best apps to incorporate into their lessons. (Learning and Teaching with iPads, 2013).

Tom Daccord identifies in his blog (2012) on the use of iPads in US schools (Daccord, 2012) five critical mistakes that schools are making but could easily avoid:

1. **A focus on subject-specific apps**. A common mistake teachers make is to overlook the full range of possibilities with the iPad because they only focus on subject-specific apps. An example is to rather use a VoiceThread App to record the students speaking Latin than looking for a Latin language App.
2. **Poor teacher preparation in Classroom Management of IPads**. When teachers have access to new technologies their instinct is to use them to maintain existing practice. Training is essential to introduce the teachers to new teaching strategies that use tablets to realise the benefits.
3. **Expecting a tablet to serve as a laptop**. Tablets facilitate student-centred, active learning and compliment, rather than replace other types of computers.
4. **Treating tablets like multi-user devices**. Tablets are designed for single users, not to be a general or shared resource, and the 1:1 element is a critical factor in making the most of them.
5. **Failure of schools to explain "why choose tablets"**. Parents, teachers and even students need to be persuaded of the reasons why the school has invested in tablets.

## 4.2 PERSONALISATION

### DEFINITION

The idea of 'personalisation' in education is based on putting the learner at the centre. Personalisation aims to make *every* student's learning experience responsive to his or her particular interests. It invites teachers to involve their learners in decision-making and to plan for their learning to maximise their motivation, relate to their background, draw on their strengths and take account of their preferred learning styles (Learning & Skills Improvement Service 2012). Personalisation is discussed here in the context of tailoring the teaching, computer device, the learning software and the curriculum, around the needs of the individual learner.

### DEMAND

The NMC Horizon report (2013) observes that the demand for personalized learning is not adequately supported by current technology or practices. While the increasing demand for education that is customized to each student's unique needs is driving the development of new technologies that provide more learner choice and control and allow for differentiated instruction, there remains a gap between the vision and the tools needed to achieve it. This is despite the fact that the notion that one -size-fits-all teaching methods are neither effective nor acceptable for today's diverse students is generally accepted among educators.

### DEPLOYMENT

The way that apps can be selected and loaded onto a device (e.g. via iTunes and Google Apps) provides significant scope to create a unique portfolio of apps for each learner; "a unique scaffolding that can be customised to the individual's path of investigation". This was particularly observed in the USA study into Android devices by 5th Graders where students exchanged information and gave advice on the best apps - "every student acted as their own device manager" (Bjerede & Bondi, 2012).

Melhuish & Falloon (2012) point out that the iPad is designed as a device for the individual learner and so has considerable personalisation potential. However, they are sceptical about the willingness of teachers to make the most of this opportunity to achieve a personalised approach. However, other evidence suggests that the students may achieve that aim regardless of their schools reluctance to embrace change (Heinrich, 2012).

Finally personalisation becomes very important when it comes to students with special educational needs. Research at Robert Wood Johnson Medical School in New Jersey, USA found readers (patients) with impaired vision gained 42 words a minute when they used an iPad to read compared to a 12 words a minute gain with a Kindle device. Backlighting and adjustable font sizes were felt to be the major causes. However, no evidence could be found to confirm this effect on young readers (Roth, 2012).

Melhuish & Falloon (2012) also recognised the value of the tablet format for users with disabilities due to screen size, lack of buttons and a wide range of assistive functions.

Under a different definition of personalisation, that of 1:1 access to a device 24/7, the iPad Scotland Evaluation was carried out by the University of Hull. Accepting this definition of personalisation, students being allocated their own device was seen as the single most important factor for increased motivation, engagement, and self-

directed learning and also more interdisciplinary activity (Burden et al, 2012). This also applied to the teachers, who were provided with their tablets ahead of the students, an important factor in the successful implantation of the pilot.

In the study at Honywood School, Longfield Academy and Wallace High School (Clarke & Svanaes, 2012), the benefits of personalisation through technology were supported by increased pupil-teacher communication via email. Work could be marked and returned soon after a lesson, so that learning was more immediate, and pupils felt supported as individuals, with any misunderstanding or difficulties in schoolwork identified far sooner than prior to the use of tablets, when feedback took several days to reach pupils.

Teachers appeared to appreciate the immediacy of marking; it helped them to make informed judgements about pupils' understanding and learning, and it assisted in monitoring individual pupil's progress. The schools reported genuine excitement over the introduction of tablets which in their opinion had led to increased motivation to learn. Pupils were reported to be more creative, independent and engaged with their schoolwork. This research is now being extended to cover over 20 schools with findings expected to be published in 2014, as part of the Tablets for Schools initiative run by Carphone Warehouse.

Teachers involved in the Flipped Classroom approach in Colorado (Edudemic,2013), and using Apple iPads, found that it facilitated personalisation and individual learning activity, which led to better grasp of concepts by students. Results generated by the Colorado Student Assessment Programme showed results in science jumped nine percentage points after the department "flipped".

Teachers in the Australian iPad Study (Goodwin, 2012) observed that the iPads made it easy to personalise learning for their students. In doing so, it made learning more authentic for the students and provided a relevant purpose for learning. As a result, there was a strong sense of student ownership of their learning. Teachers could install specific apps onto students' devices which enabled them to select apps that were appropriate for that student, rather than having a generic installation of class apps or computers with identical software. In addition, students were also provided with opportunities to select the apps to undertake a task. The students became discriminate users and were able to select the best app for the task. This empowered the students and provided an authentic opportunity for learning to be highly personalised.

## 4.3 CONTENT CREATION

Content creation in the context of tablet computers is a new area so little formal research has been found, and none has been found that focusses on content creation. This will therefore be an important topic for future research as their use becomes more widespread.

### CODING

In the UK, the Government has decided to phase out the traditional ICT curriculum and replace it with a Computer Science qualification so that a generation of coders is developed for the growing digital services industry.

A UK charity called Apps for Good runs a structured programme to help teams of students both create and commercially launch the apps that they have developed using open-source resources. The programme is extremely popular with demand out-stripping availability of places on the programme. A "Dragon's Den" style event decides which apps go forward for commercial development. About 20,000 students in 400 schools are currently involved (Apps for Good programme).

The Raspberry Pi is a low cost credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools.

### MULTI-MEDIA

Tablets have significant potential to create media in a number of formats from music, video, audio, simulation, etc. A wide range of apps allow users to generate, manipulate, manage and share content. Learners are often seen to take the initiative in finding new ways that their devices can handle media, with teachers working alongside the learner.

Clarke & Svanaes (2012) carried out research at three UK schools (Honywood School, Essex, Longfield Academy, Kent and Wallace High School, Belfast) and found that the tablets were being used in a creative way for teaching and learning, driven by the fact that content designed specifically for curriculum subjects was often lacking. To address this, teachers were creating their own content, such as interactive iBooks and video tutorials, which would then be distributed to pupils.

Some teachers felt that a lack of subject specific educational content made it necessary for them to consider using different forms of software and also think of alternative ways to teach. One example was a Latin teacher using a recording app to help pupils listen to them speaking in Latin.

### APPS

A study into the use of iPads in primary schools in Australia (Goodwin, 2012) involving 75 iPads across 3 primary schools and 2 academic terms, found that teachers felt that the best use of the devices was when students used content-creation apps to develop higher order thinking skills, and used opportunities to express their understanding in creative and individual ways. Content creation also provided opportunities for increased collaboration amongst students. Teachers also preferred content creation apps because they were not subject-

specific and could be used across the curriculum. However, the school did not permit the students to take the tablets home at night which could have limited the maximum impact they could have made.

## 4.4 FLIPPED CLASSROOM

Evidence on the Flipped Classroom does not currently include the specific use of tablet computers. However, the power of tablets to access and playback multi-media resources suggests that the considerable evidence of the benefits of Flipping, summarised below, will be further increased as tablet adoption grows over time.

### DEFINITION

The online MacMillan Dictionary defines Flipped Learning as "a method of teaching in which new material is studied at home, usually online, and activities normally done as homework are done in class" (MacMillan Dictionary, 2013). In the Flipped Classroom scenario, preparation for the lesson is conducted by the student at home using technology based, often multi-media resources and the lesson is used to discuss and explore the concept, build understanding and reinforce with collaborative work. The USA-based Flipped Learning Network believes that the idea was pioneered in the USA in 2007, with two rural USA chemistry teachers, Sams and Bergmann, providing videos to help students who often missed the last lesson of the day due to other commitments (Flipped Learning Network, 2013).

In 2012, Sams and Bergmann started the not-for-profit Flipped Learning Network and online Community of Practice called the FLN Ning, a free website for educators. By March 2013 more than 12,000 educators were participating in the Ning. On their website, hosted by the University of Colorado, it is stressed that the flipped classroom is not a synonym for online videos, and it's not about replacing teachers with videos, an online course, or students working in isolation (Bergmann, Overmyer and Wilie, 2012). Instead it is described as:

- a means to **increase** interaction and personalized **contact time** between students and teachers,
- an environment where students take **responsibility for their own learning**,
- a classroom where the teacher is not the "sage on the stage", but the "**guide** on the side",
- a **blending** of direct instruction with constructivist learning,
- a classroom where students who are **absent** due to illness or extra-curricular activities such as athletics or field-trips, do not get left behind,
- a class where content is permanently **archived** for review or remediation,
- a class where all students are **engaged** in their learning,
- a place where all students can get a **personalized** education.

A comprehensive review of research relevant to the model was conducted in 2012 resulting in a White Paper on Flipped Learning (Hamdan et al, 2012). that summarises the evidence base on the impact of Flipped Learning and concludes:

- In the Flipped Learning model there is a deliberate shift from a teacher-centered classroom to a student-centered approach.
- While there is limited quantitative and rigorous research on Flipped Learning *per se*, there is a significant body of research on **active learning** strategies that are at the heart of Flipped Learning. This evidence suggests that active learning improves academic performance (Knight & Wood, 2005; Michael, 2006)

Freeman et al, 2007; Chaplin, 2009), increases student engagement and critical thinking, and improves student attitudes. Akinoglu & Tandogan (2006) showed that problem-based active learning in science courses has a positive influence on student academic achievement with significantly fewer misconceptions.

- Musallam (2010) found that students who had studied material outside of class found it easier to learn new material in class.
- In 2010, flipping the classroom for all their 9th Grade classes at Clintondale High School in Detroit, USA, resulted in failure rates falling by 33%, and student discipline cases dropping 74% in two years, from 736 in 2009 to 187 in 2011. Parents complaints fell from 200 to 7. As a result the whole school converted to a Flipped Learning model in late 2011.
- Marshall & DeCapua (2013) note that in traditional classrooms English language learners put most of their effort into the lower levels of Bloom's taxonomy (understanding and remembering) while in the flipped classroom the teacher moves this activity outside the classroom where the student can pause, rewind and review, and uses the classroom to focus on the upper level of the taxonomy (applying, analysing, evaluating & creating).

Perceptions of the flipped learning approach have been collected by the Flipped Learning Network from a number of surveys of teachers, students and parents.

- **Teachers**: Their surveys suggest that there is a lot of persuading to be done before teachers will adopt a flipped learning model. In 2012, over 466,000 K12 students, parents, teachers and administrators were surveyed. Of the 56,000 teachers and librarians who responded, just 6% said they were using videos they had found online and 3% said they had already created videos as part of flipping their classroom. However, 18% of teachers said they were interested in trying Flipped Learning.

  A survey of 450 teachers conducted by ClassroomWindow (2012) found that 66% of teachers who were using Flipped Learning associate it with improved student performance and nearly 90% reported increased job satisfaction.

- **Students**: In contrast, nearly 60% of the students in the SpeakUp surveys (2012) agreed with the statement that Flipped Learning "would be a good way for me to learn" and 80% responded to the Flipped Learning and Democratic Education Survey in 2012 saying they experienced more frequent and positive interactions with teachers and peers during class time.

- **Parents**: For the Flipped Learning approach to be successful, parents need to be on board. Parents of 5th Grade maths students in a pilot in Stillwater, Minnesota, reported that their children's attitudes to maths were either the same or improved, that they were doing better in maths, and that they wanted the approach to continue (Stillwater, 2012).

This early evidence suggests that Flipped Learning is changing the mode of in-class instruction. A useful role of the research of the CCL project would be to monitor the issue and collect more quantitative and qualitative data on how the use of tablet computers in the Flipped Classroom affects the learning progress of different types of students, including under-performing students, assess changes in the attitudes and approach of teachers, and also track changes in parental involvement.

## 4.5 COLLABORATIVE WORK

### DEFINITION

A definition of collaborative learning from Wikipedia includes:

- a situation in which two or more people learn or attempt to learn something together. Unlike individual learning, people engaged in collaborative learning capitalize on one another's resources and skills (asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.).
- collaborative learning refers to methodologies and environments in which learners engage in a common task where each individual depends on and is accountable to each other. These include both face-to-face conversation and computer discussions (online forums, chat rooms, etc.)
- collaborative learning redefines traditional student-teacher relationship in the classroom which results in controversy over whether this paradigm is more beneficial than harmful
- collaborative learning activities can include collaborative writing, group projects, joint problem solving, debates, study teams, and other activities

Collaborative learning is heavily rooted in Vygotsky's views that there exists an inherent social nature of learning which is shown through his theory of zone of proximal development. Often, collaborative learning is used as an umbrella term for a variety of approaches in education that involve joint intellectual effort by students or students and teachers.

### EVIDENCE

Collaborative learning has been discouraged in traditional teaching approaches with a historical emphasis on students working and being assessed as individuals. However, in recent years the need to develop the skills necessary to collaborate in a work environment has started to be reflected in schools. Indeed, in the USA it has been recognised that American students can be overly competitive at times, causing difficulties for these students when they enter the workplace where collaboration is an expected way of working (teAchnology, 2012).

Early evidence from schools using tablet computers is that collaboration is a natural outcome of 1:1 access to a device, both peer to peer and student to teacher. In the case of the Longfield study (Heinrich et al, 2012) collaboration was observed as a classroom activity, with students actively debating and reviewing their learning, rather than taking part in online discussions. The author observed that this represented a yet unexploited potential.

The "Tablets for Schools" evaluation study (Clarke & Svanaes, 2012) however did find evidence of online collaboration and states that "tablets appeared to be facilitating more collaborative learning, especially through its role in improved communication. Applications such as Facetime allowed pupils to ask each other for help or discuss their schoolwork at home, and through emails they were able to keep a running dialogue with their teachers out of school. Teachers claimed that this allowed the learning they facilitated at school to continue at home, breaking down barriers between school and home, and making communication more seamless. Pupils

used the tablet in different ways and it was clear from observation of lessons that much collaborative learning was taking place. The fact that the device was both personal and portable meant that it could easily be transported in the classroom, or to a friend's house which, when combined with the tablet's communication options, enabled greater collaboration".

The Australian study of 75 iPads in primary schools (Goodwin, 2012) observed that "when students discovered a new function on the iPad, there was a domino effect, where new information was discovered by a student and then 'ripples' followed around the room."

This sharing of information between learners is a common thread through all the research to date. Future research should seek to build on what is a very small evidence base on collaborative learning to date.

## 4.6 Assessment

The NMC Horizon report (2013) observes that we are not using digital media for formative assessment in the way we could and should. "Assessment is an important driver for educational practice and change, and over the last years we have seen a welcome rise in the use of formative assessment in educational practice. However, there is still an assessment gap in how changes in curricula and new skill demands are implemented in education; schools do not always make necessary adjustments in assessment practices as a consequence of these changes. Simple applications of digital media tools, like webcams that allow non-disruptive peer observation, offer considerable promise in giving teachers timely feedback they can use".

Effective feedback for learners is widely acknowledged as being amongst the most significant mechanisms in the learning cycle (Hattie, 2008). Many apps designed for tablets have built-in feedback that helps students assess their own progress. The challenge lies in teacher assessment and reporting to parents.

In the iPad Scotland Evaluation teachers were encouraged to explore alternative forms of assessment for learning when the students each had their own tablet in the classroom. The tablets were used as a portable voting device to help the teacher assess the level of understanding, and parents reported their children appeared more willing to share their work with them when it had been produced on the tablet (Burden et al, 2012)

At Longfield Academy the tablets were used to film and photograph activity that was then used for assessment. When interviewed, students were asked whether the quality of their work had improved. 97% said it had, and 79% of teachers agreed that work quality was improving. However, more time is needed to confirm this with test results (Heinrich et al, 2012).

## 4.7 OTHER TOPICS EMERGING FROM THE LITERATURE

### FUNDING TABLET COMPUTERS IN SCHOOLS

***Parental Donations***

One funding model increasingly being implemented in England due to reducing school budgets is the involvement of donations or payments from parents. Longfield Academy in Kent collects regular donations from over 900 parents in order to be able to provide every pupil with their own iPad. Another 150 parents have already purchased an iPad for their children who are allowed to bring in their own device (as long as it is an iPad).

It is estimated that about 700 UK secondary schools (about 30%) are now benefitting from parental contributions to fund their 1:1 programmes (e-Learning Foundation 2013).

Some tax regimes recognise these payments as charitable donations which allow tax relief to be added to the value of the funds. In the UK this "Gift Aid" adds a further 25% of funds, allowing schools to make provision for pupils whose parents are less able to contribute. However, legislation in some countries (including Belgium) limits or bans the use of parental contributions (source: Partners in CCL Project).

According to an in depth analysis of 31 1:1 initiatives in 19 European countries (deploying laptops, netbooks or tablets) there are 3 main financing models emerging. In the full financing model the state or an educational authority fully finances the equipment for students in schools. This happens via grants given to schools that applied for it, or in other cases, via grants to schools and grades selected by the state. The co-financing model involves the state as a financer, but also parents or other stakeholders contribute to the financing. This model has been identified by experts as the most suitable model as various stakeholders take responsibility for the device. In a few cases, e.g. the Acer- European Schoolnet Netbook pilot, the industry provided equipment for free to schools (Balanskat, Bannister et.al, 2013).

***Bring Your Own Device***

Opinions are polarised on the Bring Your Own Device (BYOD) debate. Those who support the approach cite reduced costs to the school, student engagement and increased motivation as major benefits. Wildern School in Southampton, UK involved their students in developing their model and feel that they have an approach that is effective and affordable (Dalton, 2012).

The Secure Connexion blog lists both the advantages and disadvantages of BYOD. Advantages exclusive to BYOD (rather than 1:1 access) are centred around the savings for schools on both the purchase and repair/maintenance of the devices.

However, in an online article named "BYOD – Worst Idea of the 21st century" (Stager, 2011) the idea is described as "reckless" for the following reasons:

- It enshrines inequity i.e. better off pupils have an unfair advantage over their classmates because of the better devices and the wider range of materials and opportunities they can afford.

- The devices being bought by parents are unlikely to be suitable for learning.
- Mobile phones are not computers and lack all the functionality required from a device suitable for learning.
- The fact that mobile devices are ubiquitous and cheap does not make them suitable for learning.
- BYOD narrows the learning process to what the devices can do, rather than what the student needs to do.
- BYOD makes life hard for teachers to cope with the diversity of devices.
- The potential of using technology in the classroom is reduced to the weakest device in the room.
- BYOD programmes weaken the argument that providing technology is the financial responsibility of schools so making it harder for them to get funding for future purchases.

The e-Learning Foundation has published guidance on BYOD on its website and repeats some of the concerns raised by Stager (2011). While benefits include that the school can save costs of 1:1 provision, and may be able to reduce costs of computer suites, there are also a number of significant drawbacks listed.

The BYOD to School paper (Dixon & Tierney, 2012) produced by the Anytime Anywhere Learning Foundation and Microsoft discusses potential deployment models. They point out that BYOD as a model is being driven by school budget constraints and the consumerisation of devices. Students increasingly bring their own mobile phone into school so, on the surface, it looks like a good opportunity for a school to have 1:1 access without paying for it.

However, the authors hold deep reservations about the suitability of the BYOD model because in their view "the purpose of 1:1 learning is to create confident, flexible, self-directed, lifelong learners, and any successful BYOD programme needs to embrace and support this core premise and not detract from it." BYOD is driven by what families can provide/afford, not what is needed to support these important learning objectives, and can therefore be an inappropriate and deeply unfair model to adopt.

In the UK, JISC offers Further Education colleges detailed legal guidance on Bring Your Own Device policies as this is a widespread practice by older students, whether formalised or not.

BYOD schemes are often based on assumptions that they are financially sustainable (but many communities will find it hard to sustain regular payments), that it is cheaper for the school (but schools must factor in the additional security, network complexity and management challenges) and ease of use (making the assumption that all pupils intuitively know how to use their devices for learning).

Access to the device on a 24/7 basis is often assumed to be the case with mobile devices but there are documented examples of schools who do not allow student to take the devices home.

One commonly encountered objection to children carrying devices from school to home is the danger of them being attacked and the devices stolen. In practice this is an unfounded fear with very little evidence of widespread thefts from the insurance companies involved. Ironically, the concern is more likely to be raised when children live in disadvantaged areas, despite the fact they are the children *least likely* to have good resources at home (e-Learning Foundation, 2013).

The Belfast study (Clarke & Abbott, 2012) reports that even though the tablets at St Oliver Plunkett School had the inbuilt anti-theft tracking and remote wiping activated, the Principal would not allow the devices to be taken home for fear of the children (aged between 4-11 years old) being attacked.

## ADDRESSING THE ATTAINMENT GAP/IMPACT ON DISADVANTAGED STUDENTS

In the various analyses of BYOD schemes, a consistent concern is that of the digital divide, and the risk that a BYOD model will drive a further divide between the academic results of students from rich and poor families.

One of the advantages of 1:1 access provided by the school, in theory, is that disadvantaged students can benefit from access to learning support at home through the technology, partly overcoming some of the disadvantages of parents and carers who are less able to contribute to their children's academic education.

In the iPad Scotland Evaluation parents were observed to become more engaged with their child's learning, and observed that they were more motivated to learn, found it helped them understand difficult concepts and were more willing to complete homework (Burden et al, 2012).

## TEACHER PROFESSIONAL DEVELOPMENT

The reaction of teachers to the adoption of new learning technologies varies enormously, but there is general consensus that without a clear strategy to support teachers to develop their pedagogical approach to make the most of the technology investment in tablets students will not achieve the educational benefits hoped for.

One of the earliest pieces of research evidence of teachers using tablets comes from the USA (Vrtis, 2010) where a single school study from Chicago collected data from 116 teachers. The findings included:

- 94% teachers used the tablet for research,
- 82% used it to create teaching materials,
- 46% used it to create assessment materials,
- 60% never used the tablet to edit student work.

Classroom observations identified teachers mainly using the tablet as a supplement to the overhead projector, with the teacher staying at the front of the classroom.

This is reinforced by the results of the Acer-EUN Tablet Pilot (Balanskat, 2013), involving 379 tablet computers being used by 263 (volunteer) teachers in 63 schools across 8 European countries, and 116 students in 4 classrooms with a device. The research observed that teachers tended to use the tablets mostly in the classroom and in a somewhat conventional way for internet access, lesson planning and lesson delivery. Collaboration largely took the form of teachers exchanging teaching materials with colleagues.

The tablet was used in a variety of subjects, and there is no indication that the tablet is more suitable for any subject in particular. Most of the teachers used the tablet mainly for browsing and searching the internet to collect learning material, or for applications to prepare presentations for lessons. This type of practice suggests that the tablets provide a set ot tools and functions that can be exploited across all subjects. The evaluation also shows that the pilot teachers used a variety of different teaching methods when teaching with the tablet, alternating between frontal teaching, and teaching methods supporting collaborative and individual activities with students. From a pre-survey it became evident that many teachers already used these various teaching

approaches (with or without ICT) before the pilot, and most probably applied similar approaches when teaching with the tablet. Teachers reported to have engaged students in a variety of learning activities, individual as well as collaborative, involving them in online activities as well as offline activities. Teachers estimate an overall positive impact in a number of areas such as the development of their digital competence and their teaching methods. Teachers also know which content to use on the tablet and how to effectively integrate tablets in their teaching. The report concludes that teacher professional development is a critical element in the implementation of ICT in schools generally, but specifically for 1:1 computing programmes including tablets.

Some of the major suppliers have incorporated professional development into their marketing strategies and appear to have gained significant competitive advantage through it. Probably the best implemented is the Apple Distinguished Educator (ADE) programme, with a network of over 2,000 ADEs across the world. The programme facilitates teachers being able to learn from other teachers, and the supplier (Apple) is able to learn from the network of users to constantly develop and refine their offering (Apple in Education, 2013).

There is limited research available in this field, and the CCL project will provide a useful opportunity to explore how teachers across the partner countries have been supported, and what lessons can be learnt throughout the project.

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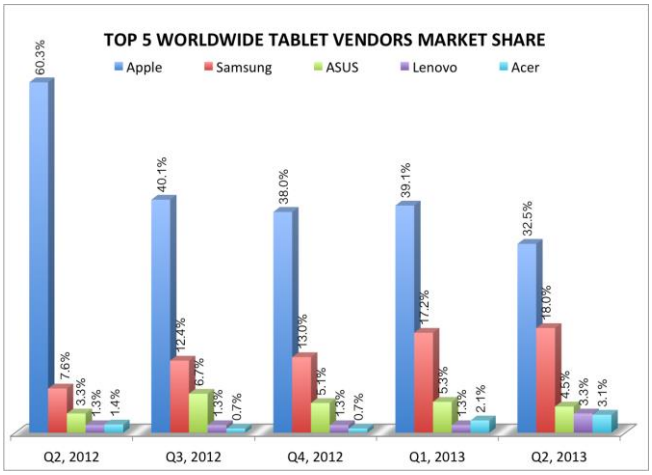
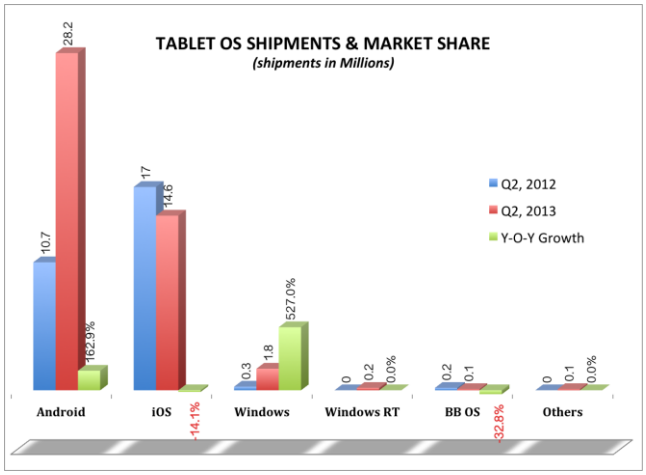
# APPENDIX 1: OPERATING SYSTEMS – AND THEIR RELATIVE MERITS

## GLOBAL TABLET SALES DATA

Apple still dominates the vendors market share tables globally but the trend shows that Samsung is fast catching them up. The latest global sales figures show 45.1 million tablets were shipped during the second quarter of 2013. Almost every tablet maker experienced slow growth in the quarter but Apple recorded negative year on year growth, 14.1% down from 17 million during the year before quarter, losing out to Android products who now dominate the OS league table.




## OPTIONS FOR SCHOOLS

**Apple iPads**

In the UK the Apple iPad has dominated the primary and secondary school sector since autumn 2011. Heinrich argues that their dominance in the UK is based on the availability of educational tools, better security, back-up and restore and lifecycle support (Heinrich, 2012).

A New Zealand study into the benefits and limitations of iPads concludes that they may offer "an exciting platform for consuming and creating content in a collaborative, interactive way" (Melhuish & Falloon, 2010).

The Apple education website is impressive and explains some of their extraordinary success in winning education market share, at least in the UK: http://www.apple.com/education/.

**Android**

In a USA study on Android devices (Bjerede, M & Bondi, 2012) the authors conclude (they report, "disappointingly") that they would not recommend Android to other schools at this stage because of the "relative immaturity of the Android ecosystem". In a blog entitled "We Need to Talk About Android" (Speirs 2012) the issues are set out in detail, and summarised here:

- ***Fragmentation of the basic operating system*** as deployed in the field. Today, iOS 5 is deployed on the majority of iOS devices in the field. By comparison, variants of Android 2.x remain vastly dominant in the installed base of Android devices. For example, Google recently shipped Chrome for Android which,

by all accounts, is a pretty great mobile web browser. Unfortunately, it requires Android 4 and around 1% of the installed base is currently running that release.

- ***Backup and Restore***. Data backup is not guaranteed to be available on all Android-powered devices and because the cloud storage and transport service can differ from device to device, Android makes no guarantees about the security of your data while using backup. This makes Android in education a risky choice where pupils must use a device to generate work for exam-level assessment, and need a 100% reliable way to back up and restore their data.

- ***Lifecycle support***. If a school is to manage hundreds of devices, it needs to know how well these devices will be supported over their lifetime of the lease. The comparison is being stuck with iOS 3.2 on our iPads today.

- ***Security***. The security problems fall into security exploits and malware. A claimed strength of Android is the ability to download software from anywhere onto your device with no walled garden or gatekeeper. The question is whether the base OS is sufficiently robust with the required security patches.

- ***Applications***. Schools using iPads are very positive about a cluster of popular apps including iMovie, GarageBand, Keynote, OmniFocus, OmniGraffle, Soulver, Flipboard, iThoughts, Noteshelf, Collabracam, The Elements, Brushes and ArtRage. These are not currently being built on Android and it may take some time for the Android community to develop a portfolio of apps with the same quality, range, depth or ambition in the Android marketplaces that are currently in the App Store.

- ***The role of the educational re-seller***. With pressures on school budgets, some suppliers are putting together packages of "educational tablets" which are often made up of low cost OEM hardware from the Far East running an obsolete version of Android and their own User Interface. When the product fails it is hard to know who to look to for an answer.

However, against this strong opposition, there is the fact that Samsung, a global leader in personal devices, uses the Android platform for its tablet computers and its mobile phones. This is an area fraught with rumours and competitor inspired criticisms, and we should be sceptical of much of the industry-generated or inspired assessment of the alternative approaches. However the Samsung website is still much more about product sales in comparison to the significant teaching and learning support offered by Apple and Microsoft. http://www.samsung.com/uk/business/industry/education

**Windows 8 Devices** have recently started to become available but may not be cost-competitive in all countries, particularly where Apple has chosen to target education with aggressive pricing and a wide range of support services including professional development for teachers through Apple Distinguished Educators (ADEs). However Microsoft has a big interest in remaining a major player in the education sector and we can expect some significant activity from them to retain what has been a historical market monopoly. http://www.microsoft.com/education/en-gb/Pages/index.aspx

Following successful trials of iPads, where benefits included the ability to engage students and help students with special needs, the Department of Education, Training & Employment in Queensland, Australia ran a trial in 2012 in two classes in each of two primary schools using 3G enabled Windows Acer tablets to see how they compared. Not all students had exclusive access, and none were allowed to take them home. Nevertheless, many of the benefits observed in many of the iPad studies reviewed in this document were also observed when the Acer tablets were in use such as collaboration, increased enthusiasm for reading, improved maths progress, etc. http://education.qld.gov.au/smartclassrooms/documents/enterprise-platform/pdf/acer-tablet-trial-report.pdf

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