D2.1 LITERATURE REVIEW
EVIDENCE OF IMPACT OF 1:1 ACCESS TO TABLET COMPUTERS IN THE CLASSROOM

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1. The Brief

This is the updated version of the literature review (v.2 – April 2015) which takes into account new evidence published within the lifetime of the project. The Tablets for Schools report published in 2014 found that ‘the interest in this area has continued to grow among academic researchers’. An overall limitation of the research to date continues to be small sample sizes and limited timeframes. (Claerke & Svanaes, 2014). This updated literature review also integrated new topics such as active learning, collaboration and assessment, independent learning skills and the use of tablets by students with special needs that have emerged as relevant within the project.

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 informed the pedagogical scenario development process in WP2 and the first mainstreaming/capacity development workshop in WP6. Monitoring of studies continued until the end of the project in M24. Identified articles are published in the resources section of the CCl website.

The first version of the literature review concentrated on identifying evidence related to the key themes and priorities identified by policy makers in the beginning of the project. The idea was to establish an evidence base around the core topics of the pedagogical scenarios, which were 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 were:

- 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.

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 still 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 5th Grade by Bjere & 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).

For the update of this literature review, conclusions from studies and reports that were published during the lifetime of the CCL project were included, including relevant sections from the literature review of the University of Minho, which reviewed the literature in relation to the support documents provided to schools to guide the implementation of the CCL pedagogical scenarios, recent studies and papers identified in the EBSCO database and recent studies publicly available from websites. Moreover, evidence of two papers that were published by
the Lithuanian CCL partner, the Centre of Information Technologies in Education are included as they provide useful evidence of using tablets for personalisation and collaboration.¹

Despite the publication of a number of recent studies at national level (e.g. France, Switzerland and the UK) on the use of tablets in schools, (relevant articles and studies can be found on the website http://creative.eun.org/resources) evidence from scientific journals remains limited and is restricted to a few case studies, or focusing on the use of tablets in preschool education, use of tablets for specific subjects and within higher education. Scientific studies on wider large scale implementation of tablets in schools are rare. EBSCO database searches included using different types of keywords (e.g. tablets and schools, tablets and pilots, tablets and impact, pedagogies and tablets, mobile learning and tablets etc.)

3. INTRODUCTION TO TABLETS ²

3.1. WHAT IS A TABLET?

Today, a tablet is a small, thin computer, with a power source of great autonomy. It is light, able to connect to networks through various protocols and has a touch screen, with fingers functioning as electric activators.

The concept of the tablet is associated with the evolution of computing and of science fiction. For example, some researchers attribute the first realistic description of a tablet to Arthur C. Clark, depicted in the cinematographic work of Stanley Kubrick as a “Newspad” (Kubrick & Clarke, 1968).

In Clark’s novel, published almost simultaneously with the showing of Kubrick’s film, we find a curious description of the “tablet” and a reference to its characteristics.


² University of Minho (2015): Tablet Use in Schools
There was plenty to occupy his time, even if he did nothing but sit and read. When he tired of official reports and memoranda and minutes, he would plug his foolscap-sized Newspad into the ship’s information circuit and scan the latest reports from Earth. One by one he would conjure up the world’s major electronic papers; he knew the codes of the more important ones by heart, and had no need to consult the list on the back of his pad.

(...) 

Floyd sometimes wondered if the Newspad, and the fantastic technology behind it, was the last word in man’s quest for perfect communications. Here he was, far out in space, speeding away from Earth at thousands of miles an hour, yet in a few milliseconds he could see the headlines of any newspaper he pleased. (That very word “newspaper,” of course, was an anachronistic hangover into the age of electronics.) The text was updated automatically on every hour; even if one read only the English versions, one could spend an entire lifetime doing nothing but absorbing the ever-changing flow of information from the news satellites.

It was hard to imagine how the system could be improved or made more convenient. But sooner or later, Floyd guessed, it would pass away, to be replaced by something as unimaginable as the Newspad itself would have been to Caxton or Gutenberg. (Clarke, 1968, Part II, Chapter 9 - Moon Shuttle)

3.2. THE FIRST TABLET

In terms of real technology, Alan Kay was probably the first computing researcher to technically design a tablet, when in 1972, as part of his doctorate, he published a basic sketch of a computer for children (see Figure 2). The Dynabook conceptualised by Kay (1972) would be something that would empower children, “something with the attention grabbing powers of TV, but controllable by the child rather than the networks. It can be like a piano [...] but one which can be a tool, a toy, a medium of expression, a source of unending pleasure and delight ... and, as with most gadgets in unenlightened hands, a terrible drudge!”. Alan Kay knew that such a computer would be useful for children of all ages and that, even if it did not save the world from a disaster, it would open up new horizons and bring new opportunities and new challenges, just as the printed book did.

Figure 2 – Dynabook, a computer for children of all ages. Sketch by Alan Kay (1972)
The “dynamic book” was extremely important to Kay, but its visionary clearly moved away from techno-centric concepts, stating that “[w]e do not feel that technology is a necessary constituent for this process any more than is the book. It may, however, provide us with a better ‘book’, one which is active (like the child) rather than passive.” Kay based his convictions on the learning theories of Jean Piaget and Jerome Brunner, which we associate today with the constructivist theories of learning.

The visionary Alan Kay, the first scientist to speak about the concept of a personal computer, would have to wait almost four decades to see the first usable computer with characteristics similar to those he had foreseen at the end of the 1960s become a reality. In fact, the iPhone, presented by Steve Jobs in 2007 (Elliot, 2012), was the closest thing to Kay’s idea, in terms of features. However, only with the launch of the iPad in 2010 can we really talk of the realisation of the Dynabook. The iPad adopted the designation of tablet, seeking to distance itself from associations with portable computers, as was the case of the netbooks (Beahm, 2011). In spite of that, the term tablet was already in use, at least since 1986, in connected with the IBM PC Convertible followed by Thinkpads in the 1990s. Still, touch screens are what best distinguish the tablets or PC tablets from other devices, placing them between the Personal Digital Assistant (PDA) and portable computers, in terms of computational capabilities and physical dimensions.

### 3.3. Tablet Characteristics

Generically, today’s tablets share a vast set of features. Multipoint touch screens (see Figure 3) recognise the simultaneous touch on various points of the surface (multi-touch), which allows for a quicker use of the interfaces with the fingers or combining the fingers with other pointers.

![Multi-touch](source: Wikipedia)

The size, varying between 7 and 12 inches in the majority of models, is suitable for using in the palm of the hand. In 2014, the weight of the main models on the market ranges between 230gr, in the lighter models, and 960gr in the heavier ones, with the average around 450 gr (Černuta, 2014), making it relatively easy to hold the device while interacting with it. This characteristic is very important if the use of the tablet happens primarily in places where it is not possible to support it on a fixed surface, since even just 300gr will become unbearable after holding it in our hands for a few minutes.

Another distinctive aspect of the current tablets is their high pixel screen density, varying between 135 and 359 pixels per inch (ppi), making them high resolution, improving not only the quality of images shown as well as making it easy to read small print text and providing better recognition of other graphic details. Processing,
storage and memory capabilities vary significantly between brands and between models of each brand. Resistance to shock, battery life, and performance of current tablets are all directly related to the price.

The architecture of these computers basically includes four distinct operating systems: iOS (Apple), Android (Google), Fire OS (Amazon) and Windows (Microsoft). Taking into consideration the question of the operating system, some architectures make available a wider range of applications than others, both free and open access as well commercial. In terms of communication protocols, tablets generally have the ability to wirelessly communicate over a local network (WLAN) known as Wi-Fi, a trademark of Wi-Fi Alliance. This feature allows for the connection between standardized Internet access points. Many models also use Bluetooth protocol to exchange information over personal communication networks (PAN or WPAN), enabling connection to other devices or the direct transfer of information between paired devices that use the same communication protocol. High-end models often include connectivity to 3G or 4G telecommunication networks, enabling access to the Internet through alternative services or the use of the tablet to complete phone calls using common mobile services.

Another characteristic common to most tablets is the integration of one or more cameras, microphone and speaker, functionalities which, controlled by small computer applications (apps), allow one to record and reproduce images and audio, making them complete and multifunctional multimedia devices.

### 3.4. Touch Interface Considerations

A tablet is a computer! Powerful! But at first glance it does not have many of the characteristics that we are used to seeing in a computer: as a rule, it does not have an attached keyboard or mouse or equivalent; it does not have a visible separate input device, nor does it have cables or removable storage drives. It is “merely a frame” with a lighted surface: the screen. But it is a touch screen, capable of “feeling” different touches and gestures. A light touch is recognised differently from a prolonged touch, dragging an object against the surface in a certain direction provides information that is different from what will be given if the dragging occurs in the other direction. Touch screens “recognise” the difference between a finger and another hard object or a pointer designed specifically for interacting with the screen – a stylus. There are basically two types of touch screens on the market: resistive and capacitive. Although it is not possible here to go into more detail on the technical differences between each one of them, it is important to emphasize that resistive screens are less precise than capacitive ones, but the latter are more sensitive to extreme temperatures.

### 3.5. Touch Screens and Learning

In terms of cognitive contribution, there are not many studies on the impact of touch screens on learning and, considering their recent introduction, neither can we expect to find real studies on the impact on subjects who are not fluent in their usage. On the other hand, it is important to realise that general-use touch devices have an even shorter history. In the United States, for example, a small study included in the evaluation of the Ready to Learn programme from the U.S. Department of Education (Michael Cohen Group & Ready to Learn, 2011) analysed the impact of iPad tablets in children from 2 to 8 years old, concluding that children progress from an immediate sensory experience to an increasingly more concrete, conceptual and abstract understanding: “children’s skills develop from novice to mastery when game play includes sequentially progressive levels and the child’s subjective experience is one of independence, autonomy and ‘doing it myself’.” The touch interface adds a certain degree of curiosity and mystery to the content, but “[i]f the interface of an App is not intuitive or
does not readily afford access, children will engage in trial and error efforts, and then quickly move on” (Michael Cohen Group & Ready to Learn, 2011). The MCG study also identified some characteristics that inhibited usage and learning on touch screen devices, highlighting:

- Apps: unclear, unfriendly or unresponsive user interface,
- game play that lacks reward or feedback,
- obscure game objectives,
- too many distractions,
- apps that lack “palm rest”, where buttons trigger themselves if accidentally touched within play area. (Michael Cohen Group & Ready to Learn, 2011)

Neumann and Neumann (2014) note that, due to their physical characteristics, tablets help literacy learning “as they are book-like in shape and are in the form of a writing/note pad (...) that detects and responds to stimulation by a finger or hand”. Conclusions convergent with those of Neumann and Neumann are given by Ayelet Segal (Segal, 2011), who concluded in the research carried out for his doctorate that touch screen interfaces were more efficient than interfaces operated with a computer mouse and helped children use more advanced strategies. Segal also observed that “action supports thinking if the action is congruent with the thinking” (p. 96), but we also see in literature serious concerns over the use of virtual keyboards (e.g. Pierce, 2012), primarily due to the size that keyboards take up on the screen, the reduced size of the keys, the difficulty of using two hands to input text when it is necessary to hold the device at the same time and the difficulty in adapting to the reactivity of the virtual keyboard and the sense of feel, which significantly reduced typing speed.

With some benevolence and enthusiasm, certain studies seem to see the emergence of literacy in correlation with the use of touch screens, due to the gestural incentive in the interaction (e.g. McManis & Gunnewig, 2012; Murray & Olcese, 2011; Neumann & Neumann, 2014) and their formal similarity to printed books, to which are added the multimedia capabilities and text editable in terms of font, size, highlighting, colour and contrast (Neumann & Neumann, 2014). Other researchers believe that, in order for the technology to be appropriate for the development of children and youth “it should be responsive to the ages and developmental levels of the children, to their individual needs and interests, and to their social and cultural contexts” (McManis & Gunnewig, 2012).

In any case, the technological impact of tablets has positive and not-so-positive aspects, and it is important to understand that their users, primarily young ones, may have different perspectives on the advantages and disadvantages of using them. The “third-person effect” (Davison, 1983) or “web third-person effect” (Antonopoulos, Veglis, Gardikiotis, Kotsakis, & Kalliris, 2015), which claims that people consider others more vulnerable to media influences than they themselves, is a phenomenon that leads individuals to not see in themselves the impact of certain effects that they recognise in others, and this can be also be seen regarding touch screen devices. In light of this effect, Victor Strasburger and colleagues call attention to the fact that media affect childhood “not only by displacing time they spend doing homework or sleeping but also by influencing beliefs and behaviors” (Strasburger, Jordan, & Donnerstein, 2010) seeing that they learn by observing and imitating what they see on the screens, especially when the behaviours seem real or rewarding.

Warnings regarding possible harmful effects from the unregulated use of digital equipment are also issued by the American Academy of Pediatrics (AAP). This organization believes that, in order for an app to be beneficial
it must, first of all, be understood by children and interesting to them. Children, however, have difficulty in distinguishing information provided by events in a video and the same information provided by someone in person. The AAP clarifies that children younger than 5 who watch television cannot play creatively or interact with real people for as long a time as those who do not watch television (American Academy of Pediatrics, 2011, 2013). Among its very large set of recommendations, the AAP urges parents to establish a family plan for using all media. “As part of the plan, enforce a mealtime and bedtime ‘curfew’ for media devices, including cell phones. Establish reasonable but firm rules about cell phones, texting, Internet, and social media use” (American Academy of Pediatrics, 2013). Regarding schools, the AAP recommends that they work in collaboration with teacher and parent associations “to encourage parental guidance in limiting or monitoring age-appropriate screen times. In addition, schools that do use new technology like iPads need to have strict rules about what students can access” (American Academy of Pediatrics, 2013).

4. 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. Innovating in education and training is a key priority in several flagship initiatives of the Europe 2020 strategy, i.e. the Agenda for New Skills and Jobs, Youth on the Move, the Digital Agenda, and the Innovation Union Agenda, and also in the latest EC Communication on ‘Opening up education’. Accordingly, one of the five targets for measuring the success of the Europe 2020 strategy is the modernisation of European Education and Training systems with the goals of reducing early school leaving and increasing tertiary education attainment (Brecko, Kampylis & Punie, 2014).

4.1. 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 report “Mainstreaming ICT-enabled innovation in Education and Training in Europe”, published in 2014, emphasizes that in order to modernise E&T systems, true ICT-enabled learning innovations (ICT-ELI) are needed that improve significantly upon the status quo and achieve scale and systemic impact (Brecko, Kampylis & Punie, 2014).

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.

<table>
<thead>
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<th>Stage of the Innovation</th>
<th>Description</th>
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| 5 Empower               | o Technology supports new learning services that go beyond institutional boundaries.  
|                         | o Mobile and locative technologies support agile teaching and learning.  
|                         | o Learners co-designer of the learning journey, supported by intelligent content and analytics. |
| 4 Extend                | o Ubiquitous, integrated, seamlessly connected technologies support learner on-tace and personalisation beyond the classroom.  
|                         | o Teaching and learning distributed, connected and organised around the learner.  
|                         | o Learners take control of learning using technology to manage own learning. |
| 3 Enhance               | o Teaching and learning redesigned to incorporate technology, building on research in learning and cognition.  
|                         | o Institutionally embedded technology supports the flow of content and data, providing an integrated approach to teaching, learning and assessment.  
|                         | o Learners produce using networked technologies to model and make. |
| 2 Enrich                | o Technology used interactively to make a differentiated provision within the classroom.  
|                         | o Technology supports a variety of routes to learning.  
|                         | o Learner as ‘user’ of technology tools and resources. |
| 1 Exchange              | o Technology used within current teaching approaches.  
|                         | o Learning is teacher or directed and classroom-like.  
|                         | o Learners as ‘consumer’ of learning content and resources. |
5. TABLETS SUPPORTING ACTIVE LEARNING STRATEGIES

One of the key objectives of the CCL project was to investigate how tablets can support active elearning strategies with students. The paper *Three Examples Using Tablet Technology in an Active Learning Classroom: Strategies for Active Learning Course Design Using Tablet Technology*, from Gerard, Joseph G.; Knott, Melissa J.; Lederman, Reena E. Global Education Journal. 2012, Vol. 2012 Issue 4, p91-114. defines active learning and explores the instructional utility of tablet technology in active learning based on specific tablet affordances, such as digital ink, portability and unobtrusiveness. The paper also explores the use of tablets and exploiting these affordances by teachers with reagards to supporting small group collaboration.

5.1. DEFINING ACTIVE LEARNING

Active learning, based on David A. Kolb’s seminal work (1984), is defined as “instructional activities involving students in doing things and thinking about what they are doing” (Bonwell & Eison, 1991, p. 1), centers on questions about what students do during class to engage in their own learning. The paper explored how the active learning instructor is able to leverage tablet technology to support student construction of knowledge, which is “an active process of articulation and reflection with a context” (Jonassen, 1995, p. 13). The authors framed the discussion around Meyers and Jones (1993) elements for active learning: talking and listening, writing, reading, and reflection activity. It then explored how the tablet characteristics were able to enhance these elements in three learning strategies: discussion teaching, simulation and, small group collaboration. The authors identified that classroom space and configuration is often assigned based upon headcount rather than the instructor’s preferred teaching style or student need for active learning experiences. In order to engage students in active learning strategies when using tablet technology the traditional classroom needs to be adapted to the space configurations in traditional classroom configurations which are not meant for or even unfriendly to active teaching and learning.

5.2. TABLET AFFORDANCES

The authors highlight three tablet technology affordances, or design characteristics: digital ink, portability, and, unobtrusiveness. Digital ink easily permits the generation and capture of information that would be difficult to record on the typically diminutive book- or smaller-sized tablet device. A pen-like stylus or finger sensitive touch screen are enough to make this possible. Add to digital ink the portability affordance, or capacity to carry tablet technology easily from place to place and use it nearly anywhere and anytime. There are, of course, limitations. However, the portability affordance provides a degree of spacial or locational flexibility that lends tablet technologies with a great deal of their value as tools. Finally, tablet technologies are generally unobtrusive which means that they allow its users to employ them effectively without focusing so much attention on the device itself. That is, tablet technologies better achieve their intended purpose when that functionality is built into their design in a way that does not distract from that purpose. Take advantage of unused class or conference rooms,
and interact where and when each group required it. These meetings leveraged key active learning moments 
that engaged students in deeper reading, discussion, and reflection during the simulation learning strategy.

For the optimal use of digital ink instructors may:

- Use colored ink and annotation for problem identification, tracking, and learner analysis.
- Use open-ended questions and white space for learner response and better understanding.
- Use handwriting, text selection, resizing, and drag-and-drop for flexible learner-driven content 
  management.
- Use immediacy in feedback and interactivity to enable greater collection of learner insight – leading 
  perhaps to a student portfolio.

For the optimal use of tablet technology portability, instructors may:

- Physically carry, hold, and use in many more settings at the front of room, around the class, in the hall, 
  and in the office with flexible information use and gathering more likely.
- Increases access to learner thought, problem identification, learner communication, and subsequent 
  analysis through physical and temporal portability.
- Take greater advantage of space and time traditionally unavailable for learning.

For the optimal use of tablet technology unobtrusiveness, instructors may:

- Make student notes without interfering with communication during meetings, class time, and 
  conferences through the flip-down screen.
- Take advantage of an apparent Hawthorne effect on participation,
- communication, and sharing with student generation of material more likely.
- Make student access to the learning process increasingly transparent and systematic.

This affordance allows its users to move technology wherever it is needed versus traditional lecture based 
computers that are rooted to the front of the classroom. Portability allows instructors and students to extend 
learning space beyond its traditional classroom boundaries to other locations that make greater sense.

**Tablet PC can support small group collaboration**

Those same tablet PC affordances that impact student learning in both discussion and simulation strategies 
above will also affect small group collaboration in many of the same ways. Collaboration exercises are active, 
almost by definition, as they require communication between group members, reading and discussing any 
written materials, writing group-produced documents, reflecting on the knowledge generation process, and 
reporting to the broader class group. This collaboration exercise requires each student group to read, discuss, 
plan, role-play, listen, and comment and question.

Instructors who use the strategies presented for tablet technologies in an active learning classroom can 
leverage the technology to support learning strategies.
6. Evidence

6.1. The potential of using tablets—early evidence

The article Enhancing Student Performance Using Tablet Computers. (Enriquez, 2010) indicates that the interactive classroom environment developed using wireless tablet PCs has the potential to be a more effective teaching pedagogy in problem-solving intensive courses compared with traditional instructor-centered teaching environment. This study focused on how tablet PCs and wireless technology can be used during classroom instruction to create an Interactive Learning Network (ILN) that is designed to enhance the instructor’s ability to solicit active participation from all students during lectures, to conduct immediate and meaningful assessment of student learning, and to provide needed real-time feedback and assistance to maximize student learning. This interactive classroom environment is created using wireless tablet PCs and a software application, NetSupport School.

The article summarises early evidence on Tablet PCs. These are essentially laptop computers that have the added functionality of simulating paper and pencil by allowing the user to use a stylus and write directly on the computer screen to create electronic documents that can be easily edited using traditional computer applications. This functionality makes tablet PCs more suitable than laptop computers in solving and analyzing problems that require sketches, diagrams, and mathematical formulas. Combined with wireless networking technology, tablet PCs have the potential to provide an ideal venue for applying previously proven collaborative teaching and learning techniques commonly used in smaller engineering laboratory and discussion sessions to a larger, more traditional lecture setting. Currently, the range of use of tablet PCs in the classroom includes enhancing lecture presentations (Rogers & Cox 2008; Ellis-Behnke et al. 2003), digital ink and note taking (Colwell 2004), E-Books (books in electronic format) that allow hyperlinks and annotations (Goodwin-Jones 2003), Tablet-PC-based in class assessments (Rogers & Cox 2008; Ellis-Behnke et al., 2003), and tablet-PC-based classroom collaboration systems such as the Classroom Presenter (Anderson et. al., 2007), and the Ubiquitous Presenter(Price, Malani & Simon 2006) that can enhance student learning and engagement. As the use of tablet PCs in the classroom grows, there is a growing need to understand how these various uses and applications can facilitate and enhance student learning.

6.2. 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

The Horizon report 2014 with a focus on Europe identifies tablet computing as one of the trends to be adopted within less one year (NMC, 2014). It also referenced the Creative Classrooms Lab project as an example of designing policies and developing capacity in support of hybrid-based teaching and learning, for nine Ministries of Education.

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 5th 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.

A study on the benefits of iPads in schools in Quebec (Canada), based on a survey of 6,057 students and 302 teachers found that incorporating the iPad into education constitutes a necessary risk that for schools, and that this technological tool has breathtaking cognitive potential. At the same time, introducing it into the classroom does not necessarily make for a smooth transition. On the contrary, this new technology can pose challenges, that teachers might find hard to cope with if they are caught unaware. The key to successful integration is of the iPad in education is therefore to provide teachers with proper training (Karsenti/ Fievez, 2013).

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”.

Research results have shown that modern mobile learning activities applying tablets based on problem solving, personalisation, collaboration, and flipped class are more flexible than traditional ones, they have more possibilities for feedback, more actively engage students in learning, facilitate interaction and collaboration, employ multiple teaching methods, and incorporate learners’ backgrounds, experiences and expectations (Kurilovas/ Juskeviciene/ Bireniene, 2014).

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Pedagogical potential</th>
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| Portability                     | • Makes technology ‘invisible’  
|                                 | • Changes where and when learning occurs  
|                                 | • Encourages learning in the 3rd Place                                                                                                                  |
| Affordable and ubiquitous access| • Makes for greater equity and inclusion  
|                                 | • 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  
|                                 | • Enables ‘just in time’ rather than ‘just in case’ learning  
|                                 | • 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.

### 6.3. 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. The NMC horizon report 2014, however, concludes that underlying technologies needed to support personalised learning are relatively straightforward and readily available now. For example, a person’s smartphone or tablet and the collection of apps they have chosen to download directly represents their assortment of interests (Horizon Report Europe, 2014). 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. The 2014 Horizon report identifies personalised learning as one of the trends likely to adopted within 4 to 5 years (NMC, 2014).

**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.

**INDEPENDENT LEARNING**

In the second year of the CCL project, the personalised learning scenario was developed further to a scenario around ‘Liberating Learners’ that puts the emphasis on developing independent learning skills of students. Mobile technology facilitates the learning outside the traditional classroom that is argued to support independent learning skills of students (Clarke & Svanaes, 2014).

**DEPLOYMENT IN THE CCL PROJECT IN LITHUANIA**

In the 5 CCL schools in Lithuania, the personalised learning approach was implemented by dividing the learners in distinct groups according to their learning styles. First of all it is important to note that there are different ways to determine students’ learning styles, e.g. questionnaires, learners’ interviews, analysis of their e-portfolios, data mining etc. In the CCL project, the Centre of Information Technologies in Education developed an online questionnaire and software to automatically establishing students’ learning styles. In the first project year, teachers used a grouping method used by Peter Honey and Alan Mumford, to determine the students’ way of thinking as theorist, activist, pragmatist or reflector. In the second project year, the VARK typology was used for this purpose. After that, students’ learning styles were interconnected with suitable learning activities, types of LOs, tools and tablet apps and learners were grouped into distinct groups according to their learning styles. This could guarantee that, in their groups, learners could learn using similar suitable LAs, LOs types, and apps.

**ACCORDING TO THE RESULTS OF AN ONLINE** questionnaire, students were motivated while applying personalised learning approach, suitable activities, tools, LOs, apps, and proper sets of learning methods. While students were interested in their learning styles, “it was hard for students to answer psychological questions, and, therefore, maybe their learning styles were identified not precisely” (Kurilovas/ Juskeviciene/ Bireniene, 2014).

**6.4. 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 focuses 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.

**6.5. 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.

### 6.6. 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.
6.7. **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).

6.8. **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).

BENEFITS OF TABLETS FOR STUDENTS WITH SPECIAL NEEDS

Tablets with their touchscreens offer multiple advantages to students with special needs. They can access a tablet much more effectively than a PC. Using a touchscreen offers immediate feedback, as what is seen and heard emanate from where the fingers are on the device. Two particular benefits of tablets for students with special needs are emerging: they motivate (Johnson, 2013) to learn (as of course do other technologies) and
they enable more personalized learning, as it is easier to individualize instruction and track progress and to erase, change, customize content to suit individual students’ needs (Robinson, June 2014). A further appealing aspect of tablets for students with special needs is their inclusivity: to bring them closer to their classmates. The Tablets for Schools report published in 2013 in the UK suggests as one of its most exciting findings that tablets are opening up a new world of possibilities for SEN students. One finding was that “with the right apps, SEN students were able to keep up with other students in the class and do assignments using the same device as their peers, in addition to receiving immediate feedback” (Tablets for schools, 2014c) and that using tablets enables students with special needs to gain a sense of achievement in learning the same material as other students in the class (Tablets for schools, 2014b). Tablets seem to offer benefits for students with special needs in general but in particular for autistic children. Findings of a small-scale study carried out by the Kennedy Krieger Institute suggest that iPads can be an effective instruction tool to enhance learning and independence of autistic children (O’Mally/ Lewis, 2013). Other groups of students that can benefit from the use of tablets are students with attention deficits, dyslexic students, students with limited fine motor control and those that are visually impaired (Panzavolta, Lotti & Engelhardt, 2014).

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 of 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).

Training includes not only technical guidance but also pedagogical discussions, recommendations and sharing of apps and teaching activities and, importantly, enough time to become familiar with the technology (Clarke & Svanaes, 2014).

Given the limited research available in this field, the CCL project will provide useful evidence via the evaluation of the two pilot phases based on classroom observation visits in each of the the CCL pilot countries (22 classroom observations in total) and provide an opportunity to explore how the pedagogical scenarios/learning stories were implemented by teachers and students and what are the drivers or barriers for the successful integration of tablets in schools.

The Interim and final observation visit report as well as key recommendations resulting from the CCL project can be found in the deliverable section of the project here: http://creative.eun.org/about
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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. 