What educational benefits do iPads offer to students with Asperger's Syndrome and Autistic Spectrum Disorders?

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Abstract

Many educational institutions are considering the implementation of a 1:1 iPad amongst the student and staff body. There has been much research into the impact of creating an institution-wide programme however little work has been done as to the impact on students who have Asperger's Syndrome or who have an Autistic Spectrum Disorder.

This research was undertaken in a maintained, coeducational, non-selective, academy of around 900 students and 100 staff in the South West of the United Kingdom and analysed the data in every curriculum subject and for every cohort for the year before the introduction of the iPads and contrasted educational progress with the year after their introduction, at which point the institution was judged to be "Outstanding" in an Ofsted inspection.

The data also included qualitative surveys into student satisfaction as to the impact of the devices in lessons and of teaching and learning support staff as to the impact on Autistic and Asperger's students.

The research showed that the iPads had a significant impact for both the general student body and Autistic students in Literacy and Numeracy, however these benefits were not universally seen in all curriculum areas.

Improvements in communication skills, independent learning, the gathering and interpretation of information for research-based tasks and other non-curriculum areas were evidenced in the staff surveys.

The overall conclusions of the research were that students with Asperger's Syndrome and Autistic Spectrum Disorder can benefit from the introduction of tablet-based electronic devices to a greater degree than the general student body in literacy, numeracy and other developmental skills but that the benefit in other areas will only come with more integration of the devices into curriculum design and, in particular, specific advice for staff not specialised in the education of students with these needs as to how to deliver a curriculum that the students can access more fully.

The research also demonstrated the difficulties in the study of curriculum progress by the transition from levels to grades at the Key Stage 3/4 boundary and the need for work on the points value scale to make the long term analysis of student progress more effective.

Table of Contents

List of Tables

Defining Aspergers Syndrome and Autistic Spectrum Disorder

For the purpose of clarity throughout this research project, the term “ASD Students” will be used to refer to students diagnosed with Asperger’s Syndrome, Autistic Spectrum Disorders or Autistic Tendencies.

From early work to define Autism by Kanner (1943) to Asperger’s identification of variations in Autism (1944), both as innate differences decided before birth and Bettelheim’s (1967) now discredited ideas of Autism as the product of students starved of affection by “Refrigerator mothers”, we have been looking for a definition of the condition that we see around us, wanting to label the differences that ASD students have, to understand and, by some, to treat or cure.

The Autistic Society of America (ASA, 2011) define Autism as a spectrum of developmental disorders following a pattern of;

> *"a complex developmental disability that typically appears during the first three years of life and is the result of a neurological disorder that affects the normal functioning of the brain, impacting development in the areas of social interaction and communication skills. Both students and adults with autism typically show difficulties in verbal and non-verbal communication, social interactions, and leisure or play activities and is one of five disorders that falls under the umbrella of Pervasive Developmental Disorders (PDD), a category of neurological disorders characterised by severe and pervasive impairment in several areas of development."*

Furthermore, the Autism and Developmental Disabilities Monitoring Network (ADDMN, 2009) explain Autism by saying that;

> *“Autism spectrum disorders (ASDs) are a group of developmental disabilities that typically begin before a student is 3 years of age and last throughout a person’s life. People with ASDs have substantial challenges in social interaction and communication. They handle information in their brain differently than other people, and might have unusual ways of*

learning, paying attention, and reacting to different sensations. ASDs are part of the broader category of pervasive developmental disorders (PDDs) and include autistic disorder, Asperger disorder, and pervasive developmental disorder-not otherwise specified (PDD-NOS)."

The term "autistic spectrum" has come to represent, as Waterhouse, et al. (2007,308) tell us;

"An aggregate of specific disorders that share some common behavioural features that involve the dysfunction of one or more, probably widely distributed, brain systems"

The issue is that there is no real agreement on what brain systems are involved and even how the spectrum can be clearly defined. Autistic Spectrum Disorders cannot, at present, be tested for (in a medical sense) but have to be identified through clinical observation, surveys, parental observations.

These definitions present Autism and Aspergers' firmly as 'disorders' and 'disabilities' focusing on the negative side of the condition. For many people on the Autistic Spectrum, this is undoubtably true however, it is important to focus on the fact that Asperger's Syndrome (AS) and Autistic Spectrum Disorder (ASD) people see the world differently from the majority and so have unique difficulties dealing with certain situations.

Right at the start of the awareness of Autism, Aspgerger (1944) described the conditions by saying that;

"We are convinced, then, that autistic people have their place in the organism of the social community. They fulfil their role well, perhaps better than anyone else could, and we are talking of people who as students had the greatest difficulties and caused untold worries to their care-givers."

It is important, therefore, to look for more positive outcomes for ASD students in education and how the curriculum can be accessed in a more complete way.

The process of education can be highly traumatic for some and yet, given the correct opportunities, can excel for, as Attwood (2007,172) tells us;

> *"Although people with Asperger's Syndrome have difficulties with the interpersonal aspects of life, most have a remarkable ability in a chosen area of expertise"*

Education is both a preparation for life and a route to finding each person's talent and nurturing it. ASD students need to therefore find a way of nurturing the "Special Interest", whilst being supported through the interpersonal difficulties.

Rapin (1994) concluded that;

> *"the inclusiveness of the spectrum has become a critical problem for genetic and brain research in Autism"*

However, Baron-Cohen, (1998 and 2005), proposes genetic links to Autism and Aspergers that go some way to explaining the perceived increase in the spectrum amongst students.

Further research has indicated prevalence of Autistic Spectrum Disorder and Aspergers Syndrome in individuals in science, technology and engineering. Roelfsema et al. (2011) have investigated the incidence of Autism in an area of the Netherlands where IT industries are based and found clear increases in Autism Spectrum Conditions. Whilst they acknowledge that there could be other explanations, these findings appear consistent with others, such as the work of some of the authors of the above report as far back as 1998 where data showed that 1 in 8 students with Autistic Spectrum Disorder had fathers who were engineers, as compared to 1 in 20 whose fathers were not engineers. (Baron-Cohen 1998)

Baron-Cohen, et al. (2003) also tell us that ASD individuals strengths in systemizing "our most powerful way of understanding and predicting the law-governed inanimate universe"

may lead such individuals to have natural aptitudes in educational fields that require such skills more than “Empathizing” which “is held to be our most powerful way of understanding and predicting the social world”.

Certainly many students on the spectrum have profound limitations in communication but, with many of the fields that high-functioning ASD students excel at being those that are in demand in a modern, technological world, Autism (and Aspergers in particular) may have an important role to play in society.

Baron-Cohen et al (2003) and (2009) went on to research and describe the implications for education of the empathising-systemising theory of autism. This also (2003,2-3) went some way to postulate a reason for the statistical difference in the number of boys on the Autistic Spectrum, as opposed to girls, due to;

> *“One final central claim of the E–S theory is that, on average, more males than females have a brain of type S, and more females than males have a brain of type E. The evidence for female superiority in empathizing is reviewed elsewhere and includes the finding that women are better at decoding non-verbal communication, picking up subtle nuances from tone of voice or facial expression, or judging a person’s character. The evidence for a male advantage in systemizing is also reviewed elsewhere and includes the findings that maths, physics and engineering (which all require a high degree of systemizing) are largely male in sex ratio.”*

When combined with the Weak Central Coherence Theory (Frith et al, 1994), Extreme Mail Brain theory (Asperger, 1944) and Mindblindness (Baron-Cohen, 1994 and others) we see the possibility of an understanding of how individuals on the Autistic Spectrum Disorder just see the world differently to the rest of the population.

Just as we would make changes to teaching methodologies for students with visual or auditory impairment, the deficits (or differences) outlined in the above theories are clear in the implication that students with Autistic Spectrum Disorder will learn differently and therefore it should be argued that it is necessary to find ways to remove the confusion amongst many in how to assist students to reach their full

potential in the curriculum and wider society, if we are to all benefit from their particular skill-sets.

Just as a neuro-typical student may gather information presented using empathic methods, understanding double-meanings, humour and other abstract comments in the lesson, the ASD student will be processing information logically and systematically even where no logical pattern existed in the information presented. This will cause frustration and an inability to access the presented tasks.

The diagnosis of Autism is therefore complex. The Autism Research Centre publish a number of surveys and tests that they have compiled in the course of their research but the diagnosis of Autism is broader than this.

The National Autistic Society (2013) publish guidelines on their website for parents who suspect their student might be on the spectrum. The process is one of observation by professionals in combination with tests. The society have developed a Diagnostic Interview for Social and Communication Disorders (DISCO) to gain a more accurate diagnosis, based on the work of Wing and Gould as far back as the 1970s.

Filipek et al. (1999) listed the “Red Flags” for Autism (See Appendix A) and the World Health Organisation classed Aspergers and Autism within classification F84 “Pervasive Developmental Disorders” (WHO, 1993) and listed clear symptomatic indicators but all present these as signs, rather than tick-boxes towards a diagnosis. Once an individual is diagnosed, however, there are clear implications for their educational progress.

Whilst it is a shame to move back the more negative ‘disability’ view of Autism, it is useful in emphasising the responsibilities of organisations to facilitate ASD students. Gravestock (2006) creates a framework for the inclusion of ASD students from 2003/04 in the attention paid to statutory guidance in further and higher education, that can be extrapolated to earlier educational stages. The implications of this are far reaching for institutions.

Within the Equality Act 2010 guidance (Office for Disability 2010), there are clear examples given for Autism to be considered as a disability and therefore, under the Special Educational Needs and Disability Act 2001, (HMSO, 2001) an obligation rests on schools to ensure that the needs of ASD students are met in the programme of education provided.

> *"28C, 1b: In relation to education and associated services provided for, or offered to, pupils at the school by it, disabled pupils are not placed at a substantial disadvantage in comparison with pupils who are not disabled"*

Gravestock tells us that (2006,9);

> *"Part IV of the Disability Discrimination Act, which is concerned with Education and which was amended by the Special Educational Needs and Disability Act (SENDA) in 2001, covers all student services, such as:*
>
> *a) teaching;*
> *b) curriculum design;*
> *c) examinations and assessment;*
> *d) fieldtrips;*
> *e) work placements and study abroad;*
> *f) research degrees;*
> *g) short courses and training courses;*
> *h) flexible and distributed learning (including distance learning and e-learning);*
> *i) learning facilities (e.g. teaching rooms, laboratories, darkrooms, etc.);*
> *j) learning equipment (e.g. handouts, laboratory equipment, computing facilities);*
> *k) libraries;*
> *l) Information Technology (including an institution's Intranet or Internet site);*
> *m) careers advice, training and resources;*
> *n) job references;*
> *o) graduation / award ceremonies;*
> *p) leisure and recreation facilities;*

q) physical environment"

It is therefore important for educational establishments to review how the needs of Autistic students are met. Holtz, Zieger and Baker (2004,2) describe six steps for the educator to consider when dealing with students on the Autistic Spectrum.

"Step 1: Educate yourself
Step 2: Reach out to the parents
Step 3: Prepare the classroom
Step 4: Educate peers and promote social goals
Step 5: Collaborate on the implementation of an education programme
Step 6: Manage behavioural challenges"

It is clear that it is essential for the educator to understand Autism, rather than simply reading the suggestions on an Individual Education Plan. The ASD student thinks differently and so has to be prepared to change the way they might deliver a concept in order to facilitate these individuals.

Reaching out to parents informs you of their child's special interests, sensory issues, strengths and areas of challenge. With this knowledge it is possible to create a positive learning environment from the start. With the introduction of IT resources, such as tablet-computers, liaison with parents will be vital to fully utilise their maximum potential.

Strategies for classroom design can be equally important. Autistic students often have heightened sensory sensitivities and noisy classrooms can be difficult places in which to focus on the tasks at hand.

Behavioural difficulties can manifest themselves and, just like the sensory issues, there can be clear triggers to cause outbursts. Creating opportunities for the ASD student to succeed can be important in reducing these occurrences.

Autistic Spectrum Disorders and Curriculum Design

Before analysing the impact of digital devices on the educational progress of students who have Aspergers Syndrome or Autistic Spectrum Disorder, it is necessary to look at past research into these conditions and how the educational system has affected their progress. At the same time, the literature poses questions as to how technology can be a part of these strategies, even where this was not originally considered.

The British Columbia Department of Education (2000,27) wrote that;

> *"The most strongly recommended approach for teaching students with autism is to use visual aids. Students often demonstrate relative strengths in concrete thinking, rote memory, and understanding of visual-spatial relationships, and difficulties in abstract thinking, social cognition, communication, and attention. Pictographic and written cues can often help the student to learn, communicate, and develop self-control."*

When one considers the strengths of a table-computer device, we can see that the ability to present rich visual information to students should be a positive factor. It should also be remembered how important work organisation and communication skills are in the effective teaching of the Autistic student.

Iovannone, et al. (2003,151-65) analysed a wide range of educational strategies to identify commonalities in effective practices with ASD students. Key was the use of family involvement and a specialised curricula that focused on communication and social interaction. A supported and structured learning environment was also presented as important. A key approach (2003, 157) was one that;

> *"supports high rates of engagement, the amount of time that the student is attending to and actively interacting in his or her social environment, has been cited as one of the best predictors for positive outcomes"*

The authors were considering “traditional” social interactions but, could the use of a communication device in a 1:1 setting assist in the creation of a more embedded social situation, where face to face contact is not a necessary part and thus social awkwardness is less of an issue?

Mastergeorge tells us (2007,24-27) that there are key strategies for teachers to use to enable ASD students to be successful in school, including;

1. *“Be social engineers - encourage social communication*
2. *Clear and Consistent Routines - assist the student in planning tasks and managing transitions*
3. *Use focused interests as a window of opportunity - allow expertise in a subject to flourish*
4. *Embrace inclusive settings - encourage Autistic Spectrum Disorder students to interact with the rest of the students”*

All of the above could be assisted with technology - providing a pervasive communication tool, an unlimited source of information about the student’s chosen subject of interest and an effective time management tool - provided that the student, the teachers and their parents are fully aware of how to achieve this. More than this, could immersion in a 1:1 implementation environment create an opportunity for the ASD student to break free of the restrictions of “normal” social interaction conventions?

Olley (1999, 595-607) described a curriculum for ASD students, within the boundary of teaching skills, that would have a useful outcome in adult life, rather than a whole curriculum, as we might recognise in school.

The focus is on the curriculum as a “treatment component” for a disorder, even quoting and article from Bryson (2007) that describes Autistic Spectrum Disorder as;

> *“a loose collection of behavioural traits and learning patterns that often coexist with mental retardation”*

This view is surprising to read in a text from 2007, given the more progressive analyses and descriptions of Autism that have developed in recent years, and leads to the curriculum of an Autistic student being decided on an individual basis, through detailed psychological assessments, to focus on the preferences of the family in such a way as to reduce problem behaviour. The concept of ‘Inclusion’ does not even make an appearance.

In fact, inclusion was not a common theme until more recently. Humprey (2008,41-46) comments on the stereotypes of Autistic Spectrum Disorder that other students, parents and even the teaching staff themselves have. The key to inclusion was the recognition that all students were individuals and that the diagnosis of Autistic Spectrum Disorder was not a limiting factor for the student, although some common themes in Autistic Spectrum Disorder students needed to be recognised and so Humphrey explores this issue by analysing in some detail how each subject in the curriculum could pose a challenge for ASD students, remembering, more positively, that;

> *“Like all other students, pupils with Autistic Spectrum Disorder are entitled to a broad and balanced curriculum.”*

The advice offered focuses on the use of models and examples to explain abstract or theoretical concepts, which ASD students often struggle with. By providing students with key digital artefacts, could this provision be made more straightforward for the teacher and so be more likely to happen in the busy school day?

The Department of Education commented on the rights of the student to a broad and balanced curriculum several years ago, through a report by Jordan et al. (1998,197) where they stated;

> *“In the UK, also, we must consider the cultural context and remember that students with Autism also have rights to a broad and balanced curriculum that meets academic as well as personal and developmental needs.”*

We therefore see contrasting views from the different approaches to Autism and school. More recently, Jordan (2007,1-6) again addresses the challenge of an inclusive curriculum. It was acknowledged that;

> *"It can be seen, nevertheless, that most specialist techniques were rooted in segregated provision. These techniques were also based on a therapeutic model of education; that is, its power to help the individuals overcome the developmental difficulties arising from their autism."*

However, it is important to recognise that the National Curriculum and its entitlement for all to a balanced education also failed to truly meet the needs of ASD students, as Jordan describes;

> *"The content and the teaching approaches of the National Curriculum in mainstream schools were not changed to accommodate students with Autistic Spectrum Disorder, as it was assumed that the content was of equal relevance to all students, albeit requiring modification and 'breaking down' to make it accessible in some cases; approaches were geared to a mythical 'norm' of how students think and learn. In fact, the model of 'breaking down' curriculum content into smaller steps (which is often effective for individuals with learning difficulties) is not appropriate for students with Autistic Spectrum Disorder, where the developmental and learning patterns are different; these students need to learn about the goal and intentional behaviour."*

So we are left with the issue that, whilst education should not be merely seen as a treatment but as an entitlement to a broad curriculum, ASD students have specific needs, and so those diagnosed as having Autistic Spectrum Disorder (and the many who are not diagnosed) are still disadvantaged.

> *"With the broadening of the diagnostic category, it became clear that the majority of students with Autistic Spectrum Disorder were in mainstream schools; often because they had not been identified, but also because they were part of the social and political movement towards inclusion."*

It is important to recognise the possibilities that IT offers in developing effective curricula, as Jordan describes;

> *"If educators teach in a way that attains diversity (and modern Information Technology (IT) techniques will make this so much easier), then more students with different minds will be able to manage in mainstream settings, without needing to have special (and certainly not segregated) support."*

Murray and Lawson (2007,155) comment further on the importance of commonplace IT tools, such as the World Wide Web and multimedia presentations in allowing ASD students to participate in online communities of special interests and present their ideas to a world of like-minded people, thus giving them the opportunity to feel included in a way that many do not in our "inclusive" education system, as they say;

> *"Even the most alienated student may find companionship and appreciative community on the Internet. As well as finding interest groups devoted to, say Thomas the Tank Engine, tram services throughout the world or the structure of DNA, autistic young people may also enjoy the respectful and non-judgemental welcome that they get on the Internet from other autistic people.... Once again, these are real people out there."*

Moving into more specific curriculum areas and the impact of Autistic Spectrum Disorder, we begin by looking at the possibilities within the mathematics curriculum.

James (2009) considers the impact of Autistic Spectrum Disorder on the learning of Mathematics. Using the Baron-Cohen AQ test, students at Cambridge University who were studying Mathematics or the Mathematical Sciences and Engineering were more likely to score more highly on the test. James comments on the possible reasons for the tendency of people with Autistic Spectrum Disorder to enjoy Mathematical studies (including many famous Mathematicians and Scientists) and so offers the idea that ASD students will benefit from full access to a Mathematics curriculum. According to James;

"When combined with high intelligence, as it often is, autism is associated with outstanding creativity, particularly in the arts and sciences. An enormous capacity for curiosity and a compulsion to understand are evident in those who have the syndrome, as is a tendency to reject received wisdom and the opinions of experts. They often suffer from depression, and mathematical work can have an anti-depressant effect. Work is a form of self-expression for the autistic who finds other forms of expression difficult; it boosts their often low self esteem."

Can providing students with a device that supports scientific and mathematical work, allow the expression of this creativity in a way that traditional approaches cannot?

In a similar way, Harbinson and Alexander (2009) look at the relationship between Autistic Spectrum Disorder and the English curriculum.

Here the traits of Autistic Spectrum Disorder that made some elements of mathematics more accessible, hampers the expression of Autistic Spectrum Disorder students in English, particularly in imaginative writing. Whilst Autistic Spectrum Disorder is most certainly a "Spectrum Disorder" as the name states, most students on the spectrum have difficulties with the use of slang, idioms and placing themselves at the centre of a plot or situation so that they might "imagine" what it would be like to be the character.

One challenging finding of their work was that;

"It is clear that those parts of the English curriculum which require the use of the imagination pose significant problems for students with a diagnosis of Asperger's syndrome. The intervention which formed the basis of the research described here accomplished little in the whole- class context, though it proved to be somewhat more successful in small focused groups. The ethos of the school is mixed-ability and it is not therefore general practice to withdraw students from class. This study in some ways negated the school ethos that the parents of these students had sought out for them. It raises questions about inclusion in mainstream education for Aspergers Syndrome individuals. If small focused groups can work,

then these students may be disadvantaged in an all-ability classroom in a mainstream secondary school."

Effectively structured tasks with plenty of support materials are key here. In previous research into the use of film to help students develop narrative dialogues, this author found that the use of film assisted students in developing the language of mise en scène by providing visual clues to develop the story. Could multimedia-enabled devices in the hand of every student allow this in a greater way through placing interactive texts and film in their hands all of the time?

Similarly, Wire (2005) reports that ASD students find MFL (Modern Foreign Languages) classes difficult due in part to their unstructured nature but also because of the need to speak about fictional situations in an abstract sense.

Crucially, MFL lessons rely on social interaction in classes and, being an area impacted more profoundly by Autistic Spectrum Disorder than any other, careful pairing in class is required in order to avoid stressful situations for the student.

One key strategy is to allow the student to playback recordings of their own speech to allow them to improve on their performance. They found that technology could have an important role to play here;

"A video camera or cassette player (or other suitable and available technology) can allow playback, thus illustrating to the pupil with autism a voice that is inappropriate in volume or speed. If a pupil is reluctant to be recorded, and many are, it is worth taking time to remove pressure and record anything and everything in 'fun' lessons, thus making recording such an integral part of the lessons that it no longer causes fear. This not only removes a barrier to one aspect of assessment, in the foreign language, but may also help them in music or English assessments and, most importantly, it allows the pupil to see a positive result from his shift of attitude."

With iPads, most have the ability to record audio and video. In a 1:1 situation, students therefore have the ability to make recordings away from the stress of the classroom and increase their language proficiency as a result.

Furthermore, Wire comments on how the strengths of ASD students can be used to learn languages effectively;

> *"There is an aspect to their lack of flexibility which can be used constructively by the foreign languages teacher: their love of routine. These are pupils who will go over and over familiar material, and some even become quite excited about returning to familiar phrases , sequences , drills , games, numbers and lists. This helps them to build up the knowledge systems that can eventually be called on automatically for speaking and understanding which are a necessary part of the structure required in an autistic pupil's learning process."*

What is interesting from the previous articles is that they all view the strengths and challenges that ASD students have in a different light within their subject area. It is clear that an effective curriculum must be designed with Autistic Spectrum Disorder in mind from the outset. This can then be used to provide a platform on which to utilise any technology embedded within it.

As mentioned earlier, the mathematics curriculum can pose challenges for the ASD student. With the "Rain Man" effect, it is often assumed that the ASD student will automatically have savant-like numerical ability but the reality is much more complex.

Mathematics, in the real world sense, is as much about transferring skills to new scenarios and communicating these ideas, as knowing how to calculate the area of every regular shape, for example.

Consider the difference between a problem such as "What is the area of a rectangle of width 3cm and height 4cm?" as compared to "George is putting a lawn in his garden. It is rectangular in shape with the longest side being 8m and shortest 3.4m. Estimate how much turf he needs to the nearest m^2?".

Which garden?
Isn't this a Maths lesson?
Why estimate when there is a clear answer?

Abstract concepts and situations can be difficult. Hypothetical situations need to be used carefully. The symbolisation involved in algebra, for example, may cause confusion. Could the availability of video mathematics revision applications, such as Khan Academy, allow the ASD student to revisit concepts for reinforcement when they become confused?

Within the Science curriculum, there are specific challenges caused by ASD students being less likely to ask "How?", "Why?" and "What happens if?" questions, due to their abstract nature.

Instructions for practical work, processes for tasks and stages of any work that is to be completed should be in clear written form, with abstract concepts explained. Here the immediacy of resources on iPads with true individualisation could have a positive impact for ASD students if staff make such resources available.

As Connelly et al. (2004,45-47) tell us;

> *"The use of IT is a powerful tool in giving (ASD) pupils the organisation they need as well as being able to retrieve information when they need it...The pupils with ASD will have difficulty in understanding diagrams if presented afterwards, isolated from the actual experiment"*

Guidance is key. Using word-processing software to present work or having pre-constructed worksheets or writing frames are vital in helping the student with Autism present their work in a structured way. Using the tablet computing device as a communication tool and access device to a repository of support materials, when they need them, could be important in compensating for the deficits in their processing skills.

Prior video examples of safety procedures, abstract concepts and reinforcement materials again can help students deal with the complex nature of much of the scientific world.

Finally, vocabulary and concept lists can help the autistic student deal with the complex terminology that may use familiar words in unfamiliar contexts and therefore create confusion.

Moving to the Design and Technology curriculum, some ASD students may have difficulty in spontaneous creativity, whereas others will be creative but unable to take criticism of their ideas or suggestions for change.

Providing ASD students with examples of design ideas from a wide range of sources can help them see that many solutions are possible for one problem. Checklists, flow charts and other visual cues for instructions can, in a similar way to Science, help reinforce processes to ensure safety. Diagrams, lists of equipment names with photos and instructions provided to revisit, should they be forgotten in the midst of interest in a new tool or material, are other resources to make available. Could this be a strategy that the tablet-computer make more simple for staff to achieve?

In the humanities, such as History, Geography and Religious Education, the Autistic student can excel at the acquisition of facts however this may mask a deep misunderstanding of their relevance or connections between them.

Having materials accessible that can allow a student to revisit the concepts away from class. Videos, interactive eTexts and other multimedia resources can help a student relate the information to deeper scenarios.

With the plethora of historical photography and video resources on sites, such as iTunesU, could the tablet-computer make these historical situations more real than encyclopaedia and textbooks can provide?

The use of IT in presenting work effectively is also important here. With 1:1 computer programmes, every student is given equal access to these resources.

Looking at Geography, we have the same fact-based material that can be an area of success for ASD students but similar interpretative skills to History that rely on empathy and social understanding are a major challenge. Some of the Geography curriculum can be similar in style to the sciences and therefore considerations from that subject area can be brought in when looking at geography.

Introducing vocabulary with concrete, visual examples for reference can have a positive effect, especially where there may be ambiguity with common word-use or abstract terminology.

Maps, when one thinks about it, are an abstract concept. The ability of mapping software on iPads, such as Google Maps, to switch between topographical drawn maps to satellite imagery can overcome this. Again, thinking of how we can augment the curriculum, video resources on foreign countries would more effective than a list of statistics or still images.

Worksheets, templates and other resources will also help with the presentation of work. Ipads make this more cost effective and therefore something that could happen in any lesson.

Similar strategies apply to Religious Education and Connelly et al. (2004,109-112) give a detailed explanation of the areas that might pose the most difficulty, together with strategies. One particular area that IT resources can help here is to provide ready access to multiple texts, to allow ASD students to explore the variety of views away from the classroom as well as video tours of religious buildings to allow them to familiarise themselves with strange situations before a visit, for example.

Within the academic subject of IT itself, ASD students normally show an aptitude for the use of computer devices and, as we will read in the next section, there are huge benefits of general IT skills however, in the subject area itself, we can still encounter areas of difficulty.

Programming, spreadsheets and other abstract conceptual areas can be difficult for some ASD students to cope with. Whilst many have strong sequencing skills, coding a solution to a given problem requires a particular logical thinking process.

ASD students can also create solutions that work perfectly for themselves but, due to the lack of empathy, they can fail to see the issues that the end user could have and are often unwilling to make changes to their work.

In addition, coursework is often based around “scenarios” and some students find it very difficult to relate to an abstract, non-existent campaign. It is therefore necessary to explain the reasons behind the use of an imaginary scenario and support the student, as far as the examination rules allow, with example resources from the same area as the scenario. for example, if the scenario is based on a restaurant, obtain menus from those in the locality.

Technology Integration and Autistic Spectrum Disorder

In Attwood's "Toolbox" (2007,162), it is noted that Aspergers Syndrome students often find the use of technology beneficial in engaging with others without the fear of immediate social contact.

Rubu's study into Aspergers and Computer Science (2010,102) looked at how students specifically with Asperger's Syndrome seemed naturally drawn to Information Technology because of its logical and reliable nature, without the complexities of human-human social interactions.

> *"Aspergers are drawn to computing because they do not have to relate to people, only to machines. They can spend their work days on their own, doing what interests them most."*

Lewis, Trushell and Woods (2005,739-755) reviewed the use of ICT to see whether group-work around technology with one ASD student in a small group of Neuro-typical students could assist the ASD student make more effective social interactions.

The non-typical behaviour of ASD students is often a cause for them to be isolated from other students who might see them as strange.

In this research, an adventure game with puzzles on a computer was used as a methodology to create conversational and team-oriented activities with a facilitator.

The findings after ten weeks of the use of the game was that the ASD student gained moderate improvements in their social interactions through the use of the game as a focus. The game itself, in this instant, wasn't the driver for the improvement but the action of problem solving in a team using an artefact that didn't change its rules in a way that some students can when playing other, less controlled games, left the ASD student at less of a disadvantage.

It is therefore sensible to ask the question as to whether the effective use of applications on a iPad give similar benefits?

Des Roches Rosa (2010) tells us of the effect of the iPad (in this case, an Apple iPad) on their student;

> *“My son Leo's life was transformed when a five-dollar raffle ticket turned into a brand-new iPad. I'm not exaggerating. Before the iPad, Leo's autism made him dependent on others for entertainment, play, learning, and communication. With the iPad, Leo electrifies the air around him with independence and daily new skills.”*

There are many of these anecdotal stories on the web, usually by parents of ASD students who seem to be working it through, largely on their own and with apparently astounding results.

Bascaramurty (2010) describes a school for students with special educational needs in the US;

> *“Emily, a profoundly autistic 13-year-old with an overgrown pixie cut and fingernails that have been cut or chewed to the quick, doesn’t fit the stereotype of an early adopter of the iPad but parents and educators of students with developmental disabilities – particularly autism spectrum disorders (Autistic Spectrum Disorder) – have celebrated its release. While the device was created mostly for media consumption, it has plenty of surprising uses for students with such disabilities.”*

Whilst these stories provide an exciting insight into the possibilities iOS and other touch devices offer, in this research I will focus on gathering quantitative and qualitative data to define these benefits more closely and create a new toolbox of opportunities for ASD students to gain the highest degree of benefit from them.

Much of the current research or reporting seems to be in the area of “Assistive Communication” applications on iPads. McEwen (2010) is currently investigating the role of such mobile technologies on social and communication support in the K-8 (primary and lower secondary) phase in Toronto schools.

As recently as 2007, Florian (2007,399) comments that little research has been done as to the impact on student outcomes of all forms of assistive technology for students with Special Educational Needs, including Autistic Spectrum Disorder and Aspergers Syndrome, and identifies this as an area for future interest.

When considering how the iPads might have an impact for ASD students, it is important to review how other technological devices have been used of the past few years.

Price (2011) studied the impact of iPads directly on ASD students within the setting of a small scale study of ten devices used as loan eBook readers and looked at interactive eBooks.

Price found that;

> *"In our small sampling, every student with autism improved when using the iPad and interactive e-book over text books, except one. However, that student answered 100% of the comprehension questions correctly on all four assessments. There were no students whose comprehension decreased when using the iPad and interactive e-book. The rate of increase in comprehension when using the iPad and interactive e-books was 21% in students in middle school grades, 25% in students in the high school grades, and 21% in students ages 18-22. All three groups showed statistically significant improvements in information acquisition when using the iPad, interactive e-books."*

Ipads were clearly useful as a reading tool and for allowing ASD students to access information, whilst they had use of the device.

Weiss (2012) reports on the work of Pederson and others at the Fraser Student and Family Center in Minneapolis using iPods with Autistic Spectrum Disorder students. Here, the iPod is used as a vehicle to deliver "Social Stories" to the students so that, in unfamiliar social situations, they can look a the iPod for topics to converse about.

Again, this is a “treatment” approach, rather than as a tool to access the whole curriculum, however it has benefited the students;

> *“One parent, Jack O'Riley, says that it is just what his fifteen-year-old son P.J. needed. Jack said, 'This really hit the mark. Like many kids with Asperger's, P.J. is baffled by the normal rhythms of social interaction: in conversation, he may blurt out too much information, or say nothing at all." P.J. is also easily distracted and has difficulty staying on task, other common traits of Asperger's. For many years, P.J.'s father posted laminated signs around their home to remind his son how to get through his day; tasks such as taking a shower, bushing his teeth, and getting ready for school.*
>
> *The use of iPod videos and slide-shows by the Fraser center (sic) has changes the use of signs in P.J.'s home. Now P.J.'s father says, in relation to the videos, 'we can plug this stuff into his little 'extended memory.' P.J. is building a library of these videos and slide-shows on his iPod, one's that are at his fingertips. P.J.'s father says, 'He can pull up a topic on his 'to do list' and find everything he needs to know.'”*

What is clear is that the reported use of iPads seems to focus on its use as a treatment or enabler for social communication, or for accessing resources in a particular way.

Moore, et al. (2005, 231-243) investigated the use of Collaborative Virtual Environments (CVEs) to create opportunities for social interaction and to create less threatening ways that ASD students can interact collaboratively.

The study found that CVEs had a marked impact on students with Autistic Spectrum Disorder as both a tool for “treatment”, that is offering ways to teach ASD students about how to interact effectively in the real-world, and as a toll for delivering curriculum materials by offering self-paced and repetitive opportunities to cover the material in a structured way. They also found that the use of avatars to express emotion was useful for the ASD students when communicating with others;

> *"the study provides evidence that the majority of students with autism in the age range studied (8-16) will be able to use emotional avatars"*

More recently, Porayska-Pomsta (2012,118) discusses the design of virtual environments to teach social skills to ASD students. They conclude that the effective use of technology with ASD students lies in the coordination between software designers and those working with Autistic Spectrum Disorder to design systems that effectively model social interaction. Again, the focus is on the device as an assistive technology.

As most iPads are consumer-oriented the only flexibility comes from the choice of software "apps". The devices have assistive capabilities, mainly aimed at visual or auditory impairment, and there are many applications designed to allow those with communication difficulties to work with their peers. However, the focus of this research is on the impact of a ubiquitous device within a school where a common set of applications are offered to students and self-choice is used to decide on additional software.

Habash (2005,6) also commented on the wider use of IT, beyond merely being an assistive technology but also confirmed the research of others, saying that;

> *"There is an excellent potential for robust technologies such as Virtual Reality to emerge and play a major role in the assistive technology field. There is a need for rapid investment in information technology experts to get closer to other fields in humanities and collaborate with the professionals to attain human-oriented achievements, for the benefit of the humans."*

Keay-Bright (2006,5) looked at the role of IT-based play in assisting ASD students to progress. The software allowed the students to change the game themselves and the teachers were enthusiastic about how the level of engagement could be used to embed the ideas into different curriculum areas, to allow access to a broader subject base. They reported that;

“In addition, Apple iBooks were introduced for students to try ReActivities in small-scale environments. The portable computer enabled students to find a quiet, comfortable space to play, which prompted suggestions that ReActivities could be fun on even smaller-scale personal devices such as Personal Desktop Assistants (PDAs), iPods, mobile phones and Game Boys.”

It was clear that the technology allowed access to the curriculum, rather than just being a tool to “treat” Autism.

With many schools investing in large scale 1:1 tablet computing schemes, it is unclear from these small-scale, often anecdotal research reports what the benefits for ASD students are, beyond simple communication improvements.

This research project will therefore endeavour to analyse the impact across the whole curriculum and provide an insight into the effectiveness of touch-screen iPads within a 1:1 scheme.

Research Methodology

The methods being undertaken in this research project will be focused on the quantitative analysis of student progress data in a UK mainstream, non-selective, co-educational secondary school that has just handed out iPads to all teachers, learning support assistants and students and the qualitative analysis of the perceptions of Learning Support Assistants (LSAs) who work with the ASD students in the school. All students and staff in the school will be given regular lists of recommended “apps” by purpose and curriculum area and the focus will be on free applications.

The key to ensuring objective evidence for any analysing any educational impact is an effective approach. To this end, through research into appropriate methods, the approach will be influenced by the work of Bell (1999,101-105) and by Burton and Bartlett (2005,17) as having elements of an *“Evaluation Research Project”*. Many of the patterns of data acquisition by Arick,J et al (2003) are also useful in this study. Their work into a long scale monitoring project on the educational progress of ASD students, whilst this was aimed at measuring progress in pre-school and early years students aged 2 to 6 years, has many useful methods to bring into this research.

With the quantitative data being used in conjunction with qualitative data gathered through surveys and interviews, models for its use will be influenced by the work of Rogers’ (1996) longitudinal study of the impact of a new teaching methodology on progress and the work of Stahmer et al (2005). Data analysis will be complex and informed by methodologies outlined by Blaxter, Hughes and Tight (2006: 217-222) and Pell and Fogelman (2002: 235-277).

The data analysis will begin with the gathering of a set of pre-iPad curriculum progress data for the academic year 2010-2011, as well as CAT scores, gender, age, Free School Meals, ethnicity and any identified special educational need. It will focus on the National Curriculum level assessments at the start of the year and look at the progress made over the year in each curriculum subject by students. This will serve as the baseline (for pre-iPad progress). Over the subsequent academic year 2011-2012, the same data will be gathered but this time over the four nine week semesters that the school uses. These will be analysed to produce a post-iPad

progression figure in each subject. By comparing the pre and post tablet data, clear evidence of the difference in progress by curriculum subject will be generated..

Students recorded as having Asperger's Syndrome, Autistic Spectrum Disorder and Autistic Tendencies will be differentiated in the evidence and analysis, wherever possible. It should be recognised, however, that this will only analyse diagnosed students and there may be wider patterns present amongst the undiagnosed students. This will then be used to generate data into the role of the iPads in the progress of students.

The strength of this approach will be in the completeness of the data set (every student in every year group over two years' worth of data) and will rely on the use of a database to correlate datasets with a spreadsheet to perform the statistical analysis. This will allow key indicators to be linked to the progress data but then anonymised.

One potential weakness will be in the use of slightly different grading nomenclatures over the two years and the possibility of staff changes and the moderation complexities generated. By selecting whole year groups and having a large dataset, hopefully these error possibilities will be minimised. Grades will be matched to the Department of Education's grade equivalence chart (Appendix 1) to ensure that progression can be measured accurately over the course of the two years.

The qualitative analysis will look at how the LSAs have noticed any behavioural changes and changes to the standard or depth of academic work. This will use the interview model outlined by Hitchcock and Hughes (1995,153-183) with a predefined script. The LSAs will be surveyed within the group of all staff, due to changes with who they support throughout the year.

It was realised very quickly that some staff might make more use of the tablet technology in their lessons and so an approach would be needed to gather student views about usefulness in each subject area with the aim of ensuring that the use of the iPads is as equivalent as possible across the curriculum and inform subject leaders.

The construction of the survey was based on techniques developed by Davidson (1970) and Sanchez (1992), who emphasised the dependence of data quality on the design of the questionnaire, and tested with a small group of randomly selected students to ensure clarity of language. The survey would be run at the end of each academic year to create a feedback loop for the subject leaders.

The survey was delivered to every student using the Forms tool within Google Apps for Education. Every student iPad was set up to have these tools pushed out to them, therefore the limitations of delivery and cost that often limit the use of surveys are eliminated in this case and the weakness is therefore student willingness to participate. As the student responses will have their email address embedded in the reply, the year group and gender can be linked to the answers before they are anonymised. The survey methodology is therefore *"Probability Samples: Simple Random Sampling"* Cohen and Manion (1994, 87).

Whilst the data gathering is progressing, a thorough literature and research analysis will be undertaken to identify any background information and evidence from other studies and qualitative evidence will be sought from any other schools using iPads or similar devices with ASD students.

The initial data analysis and findings will be prepared by May 2012, based on the semester 1 and 2 data, and final analysis of all 2011-12 data will be concluded in August 2012. Further analysis will occur in February 2013 and the findings written up. As this is an emerging topic, summaries of the research and ongoing analysis will be presented on an open blog at http://www.thefreemac.com to provide a focus for discussion with a wider range of professionals.

Further data will be gathered in 2012 - 2013 to extend the analysis, however changes in teaching methodologies over longer periods of time not connected to the 1:1 device implementation and staff turnover may have a growing effect that could impact on data accuracy. This will be published on the blog as the data will be completed after the submission date for this research project.

Research Ethics

The qualitative research being undertaken will, as stated earlier, focus on interviews with support staff who work with the ASD students. It should however be noted that the work of researchers, such as Chappel (2000), conclude that;

> *"it is widely acknowledged now that people with learning difficulties are the best people to ask if researchers want to know their views and experiences."*

We must therefore be careful that the research does not miss important information by just concentrating on the views of parents, carers, and education professionals.

Beeforth et al, (1994) also say that

> *"User-researchers bring a new and different perspective, which generates new ideas and constructs and enhances the quality of the whole research process".*

We must therefore consider the accuracy of the data and, if necessary and with full parental and individual consent, discuss in broad terms with the students, their own assessment of the impact of the 1:1 devices on their studies.

The underlying principles will be based on the BERA 2011 guidelines (BERA 2011) and the ethics policy of University College Plymouth, St Mark and St John (MarJon 2011) and their considerations to the use of Quantitative Data and the Qualitative Analysis of Questionnaires and Interviews

The quantitative data will be gathered on all students using the student data system "Capita SIMS" to produce spreadsheet export files, in Microsoft Excel .xlsx format.

These will use the admission number as a key field and, from that point onwards, all names are removed. Once the required data is synchronised, using a bespoke FileMaker Pro 12 database, from its various sources, the admission number is

replaced by a randomised index number. In this way, there will be no way that the data can be connected to any individual by an external user of any of the data files.

However, one must consider the advice of those such as Bell (2002) when conducting research projects within your own institution as it would be very easy to make assumptions about consents and co-operation that may not be fully understood by the institution or subjects.

All project proposals were submitted to the subject institution and the submission for the grant proposal, including a complete synopsis of the research methodologies, were signed off by the Headteacher. At various key stages, summaries of data will be made available to the senior leadership team, so that they are aware of the trends being discovered.

All quantitative data was anonymised and only summaries published to minimise any risk of identifying individuals. Surveys taken using online forms were optional and clearly stated that the purpose was to research the attitudes of the student body to the use of the iPads in each subject area. No personal information was gathered, other than year group, and only summary data included in the final research.

Where individual qualitative data was to be gathered by interview, it was decided during the initial project discussions, to use surveys and discussions with the Learning Support Assistants who work with ASD students, rather than the students themselves.

Whilst this may limit the depth of the data, it was felt that direct interviews with the students would cause the students too much stress, for this level of study. Should a wider investigation be required on the results of this study, individual interviews may be required.

The survey of teachers and learning support assistants was prepared such that the names of the students being studied would not be entered onto the online form. In this way, data security and anonymity of the students was ensured.

The data gathered included staff initials, to ensure the removal of any duplicate entries, which were removed as soon as the data was downloaded. Gathered data was then summarised to further limit the chance of identifying individual students or staff.

Hitchcock and Hughes (2003,295-315) provide useful insights into the qualitative analysis of data and, in particular, the key indicators of successful qualitative research.

> *“Qualitative data is inductive, innovative, emergent, exploratory and creative”*

The research being conducted here is exploring a new area. It will be important to keep reevaluating the ethical basis of the study as data is analysed and new avenues for investigation pursued as it would be very easy to rush into a new situation and breach the ethical guidelines, especially as the subject group is small and relatively easy to identify within the institution being studied.

Data Gathering and Handling Methodologies

Quantitative Data

At the subject institution, the assessment system in the year before the iPads were introduced was to report national curriculum levels for every subject three times per year, at the end of each term.

These were subdivided levels given the values .1, .3 and .7 above the level given (for example 3.1 represents a level 3c, 3.3-3b and 3.7-3a).

The same academic year the iPads were introduced, the grading was changed to four times per year and using the standard nomenclature of 3c, 3b, 3a, etc. This was also used for GCSE grades given to courses in Years 10 and 11 in all subjects and Year 9 in some, with Cc, Cb, and Ca, etc. being used to indicate a tentative grade, a sound grade and a confident grade.

To analyse the data, it was therefore necessary to assign a numerical value to each grade, in order for average to be calculated. To this end, the system listed at the DfE Standards Site (shown in Appendix B) gave a continuous numerical value scale from level 1c to A*.

The student information system (Capita SIMS) was interrogated to produce a spreadsheet of all grades for all terms for all subjects for all year groups and this exported to the main computer used for this research. The key field was the Unique Pupil Number (UPN) for each student. This was then saved as a comma separated value file (CSV).

A find and replace routine was then used to translate all grades to this new scale, the data listed in Appendix C was exported as a spreadsheet and then re-saved as a CSV file and finally these two files were then combined using FileMaker Pro, with the UPN as the key field to align the data.

To create the values for analysis, a difference was calculated from from the start of the academic year to the end and averages of these changes were taken for each assessment series to calculate a progress figure for every subject.

Using the additional data from Appendix C, values were separated for all categories. This would then allow the impact on ASD students to be studied in the context of other groups by comparing progress in the year before iPads and the year after their introduction.

Data for the first half of year two post iPad introduction was be gathered for the ASD students and analysed to see if the pattern continues for those students, however the data was less accurate as there were greater chances of other influences affecting the data, such as curriculum innovations, course and staff changes and, as a part year, topics had not been completed to a sufficient level to judge.

A longer term study may give greater insight but, as stated elsewhere, may also introduce more areas of uncertainty in the data.

Qualitative Data (Surveys on Attitudes to iPads)

In order to evaluate the views of the general population, a survey was sent out to the whole student body using Google Apps for Education Forms in the January after launch. This was tied to their email addresses and so responses could be verified to the iPad used to respond and duplicate entries removed.

The data was gathered and anonymised by exporting the data to a spreadsheet followed by stripping the year of entry from the address to sort by year of entry and then the email address was deleted.

This data was then analysed to produce satisfaction scores for each subject area as to the use of iPads within lessons and for home study. Students were also asked which applications were the most used in school and at home to see how the iPads were being used.

This survey was then repeated in the January of Year 2 to see if attitudes had changed. A copy of the survey is included in Appendix D.

The analysis would look at attitudes towards the iPads and use this to compare perceived usefulness in subjects with their progress scores. Based on previous surveys, a response of at least 10% of the student body could be expected.

Qualitative Data (Surveys of Teaching and Learning Support Staff)

One of the key areas of commentary in the literature on iPads and Autistic students is the effect on communication, confidence and independence.

To this end, the survey of staff was carried out with the direct aim of assessing progress in these areas, as well as the staff opinion on how students had progressed in subject areas. This would allow inference of progress where the data was inconclusive or where progress was hard to measure, such as subjects with a Pass/ Fail grading.

Data Analysis and Presentation of Findings

Quantitative Data Analysis - All Students

When the data was analysed, it became clear that the method of assessment for the subjects outside the English Baccalaureate core were such that comparisons of whole year progress were more complex. In particular, subjects that were on a termly or half-termly carousel were only assessed once a year. The core subjects were also compulsory for the whole cohort giving an overall sample size of approximately 185 per year group.

It was therefore decided to focus on English, Mathematics, Science, Modern Foreign Languages and the Humanities, as the data was more consistent and could give longer periods of progress data to compare. An extension to the research could be to better analyse progress in non-core subjects.

With Science, as the students were streamed into BTEC and GCSE routes, the data for progress in Year 9 would need to be examined more closely. Further analysis was possible for Mathematics and English for progress in Year 10 going into Year 11 post-iPad introduction.

Each grade was changed, as stated, to the common point value. The difference between the start of the year to the end was calculated for each student. This was then averaged for each cohort.

As the scale has six points between each level, the average differences were divided by six to produce a figure in levels. It was decided to round this to two decimal places, as this was the boundary of reliability.

The values in all subsequent tables are therefore the fractions of a level gained from the start of an academic year to the end, unless stated otherwise in the table description.

The curriculum materials and delivery vary from year group to year group so the comparison would need to be for each curriculum year, rather than following the cohort. To ensure that there were no significant differences in each cohort, the NFER CAT data was collected and averaged to show the ability level of each group.

For the target group, whilst averages were suitable for showing overall progress of larger numbers, this would not be valid for the small number of students diagnosed with Asperger's Syndrome, Autistic Spectrum Disorder and Autistic Tendencies. Overall averages would be calculated but then specific students identified and their progress calculated.

A longer term study should follow patterns per cohort, perhaps beginning with Years 7 and 8, following them through for three years to 10 and 11 to gain a greater understanding of the impact of IT on progress. When this data is broken down further by subject and year group, we see that there is significant variation in progress both before and after the introduction of iPads within a subject area as you progress from year 7 to year 9.

Over the next pages, the subject data is presented for before and after iPad introduction for individual subject areas and offer interpretations of the data. With the small sample size (n=15) for students with Asperger's Syndrome, Autistic Spectrum Disorder and Autistic Tendencies, it will be necessary to map their progress, before and after the introduction of iPads, following each cohort through and examining the data for anomalies.

The overall picture shows that the impact of the iPads is not always positive for the student population as a whole but that individual subjects and groups, such as Male Reading, Statemented pupils in History, and others, can show positive benefits of the devices. The following pages will investigate this in more detail to better define the overall picture.

	Verbal Reasoning	Non-Verbal Reasoning	Quantitative Reasoning	Average CAT	% Difference
Year 7 Pre tablet	103.50	106.55	102.59	104.21	
Year 7 Post tablet	100.94	106.74	101.34	103.01	-1.17
Year 8 Pre tablet	104.00	108.00	102.60	104.87	
Year 8 Post tablet	103.50	106.55	102.59	104.21	-0.63
Year 9 Pre tablet	101.66	106.12	101.00	102.93	
Year 9 Post tablet	104.00	108.00	102.60	104.87	1.85
	Table 1:NFER Data for the cohorts: Values are the Standardised Assessment Score				

	En Write	En Read	Ma	Sc	MFL	Gg	Hi	RS
All Students	0.21	0.26	0.24	-0.38	-0.56	-0.90	0.27	0.20
Female	0.24	-0.05	0.29	-0.48	-0.53	-1.15	0.17	0.38
Male	0.17	0.59	0.20	-0.28	-0.48	-0.67	0.35	0.23
No identified Need	0.20	0.07	0.01	-0.53	-0.45	-0.99	0.33	0.19
School Action	0.26	0.72	1.17	-0.15	-0.34	-0.82	0.18	0.09
School Action Plus	-0.04	0.04	0.43	0.04	-2.07	0.74	1.09	-0.07
Statemented	0.94	2.61	-1.09	0.46	-0.49	0.17	1.50	1.35
Any Identified Need	0.33	0.89	0.63	-0.18	-0.25	-0.62	0.42	0.28
Communicatio n Difficulties	-0.28	1.14	0.16	0.12	-0.47	1.05	-0.47	0.24
Not Free School Meals	0.22	0.16	0.28	-0.37	-0.55	-0.95	0.31	0.22
Free School Meals	0.11	0.94	0.07	-0.38	-0.69	-0.75	-0.82	-0.26
	Table 2: Progress Summary Table: Numbers represent the difference in levels gained per year before and after the introduction of iPads							

English Language - Reading

With English the data is split into reading and writing. As can be seen, the data has huge variations between groups within a year and between year groups.

There was a reading programme that ran in conjunction with the 1:1 rollout to ensure that the reading of paper-based fiction did not drop, however students were allowed to read ebooks during some times within the research programme and thus the variation cannot simply be assigned to the 1:1 devices or to the reading programme.

	En Read Y7 2010	En Read Y7 2011	En Read Y8 2010	En Read Y8 2011	En Read Y9 2010	En Read Y9 2011
All Students	0.71	0.96	0.85	0.84	0.95	1.36
Female	0.69	0.94	0.94	1.02	1.16	1.60
Male	0.73	0.98	0.76	0.69	0.74	1.08
No identified Need	0.75	0.99	0.88	0.91	1.11	1.48
School Action	0.58	0.58	0.63	0.67	0.52	1.02
School Action Plus	0.68	0.63	0.71	0.56	0.71	1.18
Statemented	0.00	2.67	1.00	1.25	0.38	1.43
Any Identified Need	0.51	0.80	0.62	0.71	0.40	1.15
Communication Difficulties	0.69	0.50	1.00	0.60	0.50	0.83
Not Free School Meals	0.73	0.95	0.86	0.89	0.97	1.39
Free School Meals	0.61	1.02	0.78	0.56	0.67	1.14
	Table 3: English Reading / Literature					

English Language - Writing

Again, when we look at the pattern for English Writing, ASD students will be reported on separately but, whilst there are still large differences between groups, it can be seen that the general pattern is much more positive.

All year groups performed better in the year after the introduction of the iPads and, in particular, the group whose data was labeled as “Statemented”, performed much better in every year group studied.

	En Write Y7 2010	En Write Y7 2011	En Write Y8 2010	En Write Y8 2011	En Write Y9 2010	En Write Y9 2011
All Students	0.64	0.78	0.76	0.86	0.92	1.46
Female	0.65	0.85	0.83	0.96	1.12	0.64
Male	0.62	0.70	0.69	0.78	0.72	2.32
No identified Need	0.67	0.81	0.84	0.91	1.05	1.06
School Action	0.53	0.39	0.55	0.77	0.58	2.68
School Action Plus	0.59	0.56	0.48	0.56	0.73	0.81
Statemented	0.14	2.33	0.23	1.58	0.38	4.67
Any Identified Need	0.50	0.63	0.41	0.76	0.44	2.62
Communication Difficulties	0.56	0.75	0.50	0.97	0.38	3.13
Not Free School Meals	0.65	0.75	0.81	0.89	0.94	1.23
Free School Meals	0.55	1.02	0.46	0.68	0.71	2.84
	Table 4: English Writing / Language					

Mathematics

The pattern for Mathematics saw the differences more marked, with some groups making much bigger progress than others.

A closer look at individual group data shows some groups making less progress, post-tablet, than in the year before, whereas some groups made much better progress. As Mathematics made extensive use of objective, standardised tests at the end of teaching units, the data reliability should be high and therefore these variations are true reflections on those groups of students.

	Ma Y7 2010	Ma Y7 2011	Ma Y8 2010	Ma Y8 2011	Ma Y9 2010	Ma Y9 2011
All Students	0.81	0.84	0.57	1.04	-0.73	1.45
Female	0.79	0.81	0.64	1.20	-0.85	1.24
Male	0.82	0.86	0.49	0.90	-0.62	1.64
No identified Need	0.61	0.88	0.95	0.98	-0.83	0.62
School Action	0.93	0.24	-0.29	1.16	-0.93	4.53
School Action Plus	2.31	0.84	-3.13	1.33	0.75	0.00
Statemented	0.75	1.13	0.98	2.23	0.44	-2.58
Any Identified Need	1.63	0.53	-1.08	1.36	-0.60	2.37
Communication Difficulties	1.38	2.00	-0.83	1.81	-0.33	-1.00
Not Free School Meals	0.63	0.84	0.64	1.05	-0.78	1.40
Free School Meals	2.07	0.81	-0.08	1.04	-0.08	2.26
	Table 5: Mathematics					

Science

The pattern for Science showed a negative impact of the 1:1 implementation across most groups, however students with statements showed the highest improvement.

The progress of most students was still positive, but at a slower rate than in the year before.

The exception to this was significant with the year 9 cohort. This coincides with the introduction of BTEC Science for lower ability students and so the move to a coursework-based qualification may benefit this group of students disproportionally.

With the iPads to hand, the ability of students to research material for the BTEC evidence portfolio should have produced a significant impact.

	Sc Y7 2010	Sc Y7 2011	Sc Y8 2010	Sc Y8 2011	Sc Y9 2010	Sc Y9 2011
All Students	0.92	0.17	0.89	0.36	0.25	0.28
Female	0.93	0.22	0.86	0.42	0.45	0.09
Male	0.92	0.11	0.93	0.32	0.06	0.51
No identified Need	0.96	0.24	0.97	0.42	0.57	0.34
School Action	0.68	-0.26	0.63	0.17	0.27	0.21
School Action Plus	0.80	0.01	0.50	0.21	-1.96	-0.44
Statemented	0.95	-0.33	0.71	0.58	-2.83	0.64
Any Identified Need	0.81	-0.24	0.60	0.25	-0.68	-0.04
Communication Difficulties	0.81	-0.25	0.58	0.50	-2.50	-0.25
Not Free School Meals	0.87	0.22	0.92	0.38	0.30	0.29
Free School Meals	1.19	-0.14	0.68	0.23	-0.31	0.20
	Table 6: Science					

Modern Foreign Languages (French, German and Spanish)

Again a complex picture and the overall data analysis for all MFL was calculated across the whole population, using data from all modern languages studied.

Overall, the picture is generally of a negative impact in the year 7 and 9 cohorts but a positive impact in the year 8 cohort.

	MFL Y7 2010	MFL Y7 2011	MFL Y8 2010	MFL Y8 2011	MFL Y9 2010	MFL Y9 2011	MFL Y10 2011
All Students	2.55	1.52	1.76	2.42	1.33	1.03	0.41
Female	2.67	1.46	1.85	2.59	1.10	0.84	0.54
Male	2.44	1.60	1.64	2.28	1.47	1.34	0.31
No identified Need	2.30	1.47	1.76	2.42	1.09	0.98	0.40
School Action	3.34	1.78	2.50	2.55	0.68	1.29	0.69
School Action Plus	3.09	1.50	1.79	2.63	3.26	-0.12	0.31
Statemented	2.20	1.50	2.44	1.83	0.70	0.92	
Any Identified Need	3.01	1.88	1.39	2.35	1.14	1.06	0.65
Communication Difficulties	2.69	1.50	0.42	2.33	1.61	0.75	-0.50
Not Free School Meals	2.50	1.51	1.77	2.41	1.32	1.02	0.43
Free School Meals	2.80	1.63	1.94	2.53	1.48	1.36	0.06
	Table 7: Languages						

Humanities (Geography)

Again, as with Science we see a negative impact of the 1:1 implementation across most groups, however all could be described as having made some progress within each academic year. The data for 2011-2012 (post-device) shows some very large jumps in levels and therefore some uncertainty must be considered with this data.

	Gg Y7 2010	Gg Y7 2011	Gg Y8 2010	Gg Y8 2011	Gg Y9 2010	Gg Y9 2011
All Students	1.58	0.25	1.05	0.28	0.27	0.88
Female	1.97	0.29	0.91	0.31	0.82	0.47
Male	1.20	0.20	1.25	0.27	-0.31	1.33
No identified Need	1.66	0.22	1.04	0.28	0.22	0.55
School Action	1.30	0.50	1.66	0.35	-	1.68
School Action Plus	1.09	0.42	1.64	0.24	-	8.25
Statemented	0.50	0.50	1.25	0.38	2.00	2.25
Any Identified Need	1.25	0.44	1.19	0.37	0.43	2.40
Communication Difficulties	0.81	0.00	0.75	0.75	1.00	4.75
Not Free School Meals	1.64	0.18	1.13	0.29	0.28	0.85
Free School Meals	0.99	0.69	0.93	0.17	0.00	1.50
	Table 8: Humanities: Geography					

Humanities (History)

Here the picture is much more complex. There appears to be a negative difference between History in Y9 2010 to Y9 2011 however, although the NFER data showed little difference between cohorts, when one looks at the Y8 2010 group and track them through to Y9, it can be seen that the data shows an improvement.

This was the one subject studied that the data made tracking before and after the device implementation very difficult. Introducing the data for Year 10 in 2011 does not further clarify the data and therefore it will be difficult to draw accurate conclusions as to the impact of the iPads in this subject area.

	Hi Y7 2010	Hi Y7 2011	Hi Y8 2010	Hi Y8 2011	Hi Y9 2010	Hi Y9 2011	Hi Y10 2011
All Students	0.74	0.65	-1.36	0.94	0.32	-0.70	-0.11
Female	0.92	0.76	-1.04	0.92	0.10	-0.78	-0.26
Male	0.57	0.50	-1.60	1.01	0.57	-0.61	0.05
No identified Need	0.67	0.64	-1.22	0.99	0.44	-0.33	-0.10
School Action	0.94	0.40	-1.73	0.98	0.17	-1.57	0.29
School Action Plus	1.31	0.38	-5.25	0.75	-2.67	-2.48	-0.90
Statemented	0.07	5.38	1.50	0.71	0.00	-0.42	-
Any Identified Need	1.05	0.79	-1.59	0.91	-1.53	-1.69	-0.39
Communication Difficulties	1.13	0.75	-0.75	1.00	0.00	-2.50	-0.75
Not Free School Meals	0.79	0.62	-1.27	0.99	0.18	-0.66	-0.02
Free School Meals	0.39	0.86	-1.11	0.65	2.81	-0.91	-1.80
	Table 9: Humanities: History						

Humanities (Religious Studies)

Here the picture is more positive, with all year groups making a improvement however, some data groupings within the years do not make the same positive change from pre-tablet to post-tablet. In particular, students marked as receiving free school meals fared less well than non-free school meals students in years 8 and 9.

	RS Y7 2010	RS Y7 2011	RS Y8 2010	RS Y8 2011	RS Y9 2010	RS Y9 2011
All Students	0.82	1.01	0.19	0.91	0.38	1.23
Female	0.76	1.09	0.57	1.05	0.18	1.11
Male	0.85	0.89	-0.21	0.81	0.06	1.46
No identified Need	0.81	0.95	0.19	0.96	0.07	0.82
School Action	0.83	0.96	0.06	0.96	0.92	2.15
School Action Plus	1.12	1.15	-1.70	0.69	-	2.52
Statemented	0.00	4.17	5.43	0.72	-	1.83
Any Identified Need	0.97	1.41	-0.06	0.72	0.98	2.01
Communication Difficulties	0.91	1.50	2.55	0.61	-	1.92
Not Free School Meals	0.84	1.04	0.14	0.95	0.36	1.29
Free School Meals	0.58	0.77	1.66	0.57	1.07	0.69
	Table 10: Humanities: Religious Studies					

Quantitative Data Analysis - Autistic Students and those with Asperger's Syndrome

The pattern in data for individual year groups for students with Autism and Aspergers was calculated by taking the data for each individual and it was therefore possible to track cohort progress in a more precise way.

English Reading / Writing and Language / Literature

With English Reading, whether one follows a cohort through or averages by academic year, the variation is clear. The 2010 (Pre-Ipad) year saw a huge difference in progress from one year group to another. However, there is a general pattern of improved progress from the 2010 to 2011 academic year.

The pattern for the same group shows a mean improvement from pre-iPad to the first year after introduction. Again there is a large variation between cohorts (and individuals) but the overall pattern is as before, with a slight improvement in the first year after implementation. Whilst the dataset was based on a small group, the individual student data showed a similar pattern with little difference between higher and lower ability students.

	2010	2011		2010	2011
2008 Intake	Y9 En Read	Y10 En Read	2008 Intake	Y9 En Write	Y10 En Write
	0.43	0.83		0.33	0.81
2009 Intake	Y8 En Read	Y9 En Read	2009 Intake	Y8 En Write	Y9 En Write
	0.83	2.17		0.50	0.17
2010 Intake	Y7 En Read	Y8 En Read	2010 Intake	Y7 En Write	Y8 En Write
	0.11	0.11		0.22	0.67
2011 Intake		Y7 En Read	2011 Intake		Y7 En Write
		0.33			0.33
Averages	0.46	0.86	Averages	0.35	0.50
	Table 11: English Reading and Writing for ASD Students				

Mathematics and Science

The pattern is more complex here as the variation between individuals within the year group was higher than for English. There was also a complication within the 2008 intake's Y9 grade as the first assessment was in levels but the second in GCSE levels.

The general pattern is, however, as before with a general improvement after the implementation of the iPads. Individual students performed less well than others however the general pattern continued the trend seen in English.

Science

The pattern here does not fit that seen in English and Mathematics with a drop in progress, as compared to before the iPads were introduced.

Looking at individual student data, the general picture is as the data table implies, with less progress in the 2011 year.

	2010	2011		2010	2011
2008 Intake	Y9 Ma	Y10 Ma	2008 Intake	Y9 Sc	Y10 Sc
	-0.07	-0.62		0.00	-0.31
2009 Intake	Y8 Ma	Y9 Ma	2009 Intake	Y8 Sc	Y9 Sc
	0.00	1.00		0.67	0.17
2010 Intake	Y7 Ma	Y8 Ma	2010 Intake	Y7 Sc	Y8 Sc
	0.33	0.67		0.56	0.22
2011 Intake		Y7 Ma	2011 Intake		Y7 Sc
		0.33			0.33
Averages	0.09	0.35		0.41	0.10
	Table 12: Mathematics and Science for ASD Students				

Modern Languages and Humanities

The data here is affected by the number of students who cease studying languages in Key Stage 4. Overall, less progress was made in the second year with those who studied a language through to the GCSE years. However, lower down the year groups, progress was better in the second year. Only four out of the nine students being researched in the 2008 and 2009 intake year groups continued with any foreign language on to a GCSE programme. With the 2010 year group, only one out of three subjects continues on to the 2012 academic year.

	2010	2011		2010	2011
2008 Intake	Y9 MFL	Y10 MFL	2008 Intake	Y9 Gg	Y10 Gg
	1.05	0.00		0.20	-0.33
2009 Intake	Y8 MFL	Y9 MFL	2009 Intake	Y8 Gg	Y9 Gg
	1.17	0.00		2.00	-
2010 Intake	Y7 MFL	Y8 MFL	2010 Intake	Y7 Gg	Y8 Gg
	0.67	1.00		0.45	0.17
2011 Intake		Y7 MFL	2011 Intake		Y7 Gg
		1.33			1.00
Averages	0.96	0.78	Averages	0.88	0.28
	2010	2011		2010	2011
2008 Intake	Y9 Hi	Y10 Hi	2008 Intake	Y9 RE	Y10 RE
	0.20	-0.67		0.43	0.43
2009 Intake	Y8 Hi	Y9 Hi	2009 Intake	Y8 RE	Y9 RE
	0.50	-		0.00	-
2010 Intake	Y7 Hi	Y8 Hi	2010 Intake	Y7 RE	Y8 RE
	0.67	0.17		0.83	-0.38
2011 Intake		Y7 Hi	2011 Intake		Y7 RE
		0.33			0.00
Averages	0.46	-0.06	Averages	0.42	0.02
	Table 13: Modern Languages and Humanities for ASD Students				

The data for History, Geography and Religious Education shows a slight drop in progress after the implementation of the iPads, however the small dataset size for the 2009 intake continuing with these subjects as GCSEs means that the apparent better progress in this year group may not have statistical significance.

Overall, the students did less well in the humanities in the second year.

Overall comparisons

In this final table on quantitative data analysis, we see that the students in the focus group perform better than the whole student body in English and Mathematics but less well in other areas.

Looking at the cohort data, there are some students that don't follow the overall trend, however the general pattern is strong.

Subject	Sample	2010	2011	Pre tablet to Post tablet Difference	ASD Vs All Data
En Read	All Data	0.84	1.05	0.21	
	ASD	0.46	0.86	0.40	0.19
En Write	All Data	0.77	1.03	0.26	
	ASD	0.35	0.50	0.15	-0.11
Ma	All Data	0.22	0.46	0.24	
	ASD	0.09	0.35	0.26	0.02
Sc	All Data	0.69	0.31	-0.38	
	ASD	0.41	0.10	-0.31	0.07
MFL	All Data	1.69	1.13	-0.56	
	ASD	0.96	0.78	-0.18	0.38
Gg	All Data	1.31	0.42	-0.89	
	ASD	0.88	0.28	-0.60	0.29
Hi	All Data	-0.07	0.19	0.26	
	ASD	0.46	-0.06	-0.52	-0.78
RE	All Data	0.75	0.95	0.20	
	ASD	0.42	0.02	-0.40	-0.60
	Table 14: Summary of all data for ASD Students				

Qualitative Data - Student Surveys

The student body was surveyed as to their opinion as to the usefulness of the table-devices in each subject area.

The response was 224 out of 900 students (25%) and the graphical presentation of the data can be found in Appendix E but the summary table below demonstrates the general pattern.

	Overall	En	Ma	Sc	MFL	Gg	Hi	RS
Year 7	6.99	7.12	5.72	6.40	6.34	6.30	5.85	6.70
Year 8	7.49	7.39	5.07	6.61	6.83	6.84	7.48	7.63
Year 9	6.56	6.67	4.18	6.60	6.03	6.11	5.97	6.65
Year 10	5.59	4.90	4.59	5.76	5.15	4.18	5.36	6.11
All	6.66	6.52	4.89	6.34	6.09	5.86	6.17	6.77
Progress Data	-0.13	0.23	0.24	-0.38	-0.56	-0.90	0.27	0.20
	Table 15: Student Survey 2011: Data represents a score from 1 (iPads of no use) to 9 (iPads extremely useful).							

Overall, it can be seen that there was a positive feeling towards the use of the iPads at this point in the implementation but, when compared to the data for the difference that the introduction of the iPads made to student progress, it can be seen that there is no relationship between how useful students felt the devices were compared to how much of a difference they actually made.

It was clear that students in Year 11 (whose data is not considered in the progress analysis) felt the iPads to be less useful. This was largely due to them being half-way through the course materials and therefore already in a pattern of learning that was difficult for some subject areas to change from. Their response data is included in the appendix for reference.

Anecdotally, students commented that the devices allowed them to be more effective at researching materials and communicating with their teachers.

In the second year after implementation, when the device use should be mature in faculties, the same survey was run. Again a good sample size (n=171) and a quick response to the request for data of 48 hours.

The data includes the previous table's groups of 7-10, this time one year on as 8-11, with the new year 7 involved. Only Year 9 and above had experienced the school without the iPads.

Girls found the devices more useful than boys in all subjects, except for Science and History. Year 11 found the devices the least useful with Maths and Geography scoring particularly low. This was in part due to an emphasis on a maths revision tool that was based on Adobe's Flash technology that was incompatible with the devices, students were required to use the calculators that they would be allowed to use in the final examinations and printed examination papers were used to ensure familiarity with the style of writing in examinations.

Group	Overall	En	Ma	Sc	MFL	Gg	Hi	RS
M	6.41	6.83	5.42	6.45	5.16	5.52	6.05	5.86
F	6.82	6.68	5.62	5.86	5.44	6.13	5.82	6.21
7	7.20	7.16	6.50	6.22	5.51	6.79	6.49	6.61
8	7.28	6.70	6.19	5.93	6.02	6.48	6.16	6.38
9	6.79	6.71	5.15	6.35	5.29	5.74	5.41	6.30
10	5.93	7.00	4.96	5.74	4.37	5.26	5.26	4.89
11	4.25	5.19	2.63	6.13	4.46	2.00	5.08	5.13
All	6.66	6.74	5.54	6.09	5.33	5.89	5.91	6.07
Progress Data	-0.13	0.23	0.24	-0.38	-0.56	-0.90	0.27	0.20
		Table 16: Student Survey 2012: Data represents a score from 1 (iPads of no use) to 9 (iPads extremely useful).						

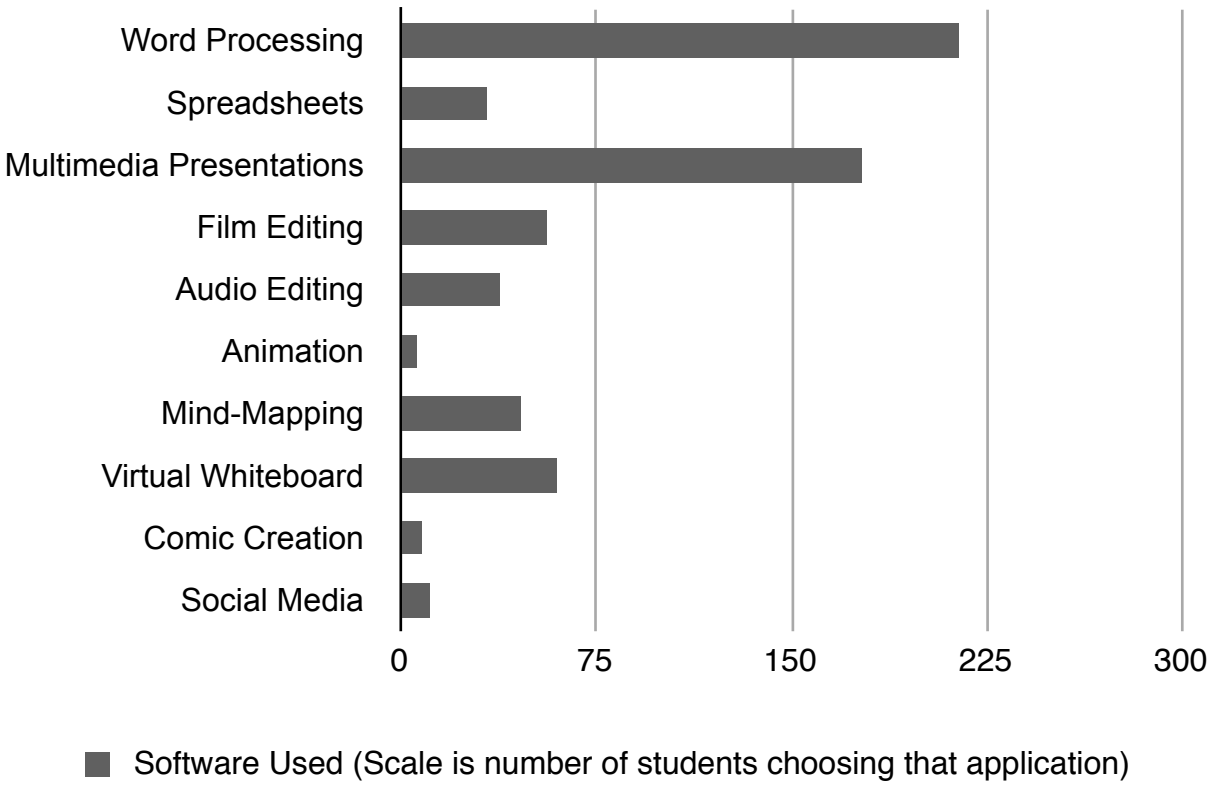
Group	Overall	En	Ma	Sc	MFL	Gg	Hi	RS
2011 - 2012	6.66	6.52	4.89	6.34	6.09	5.86	6.17	6.77
2012 - 2013	6.66	6.74	5.54	6.09	5.33	5.89	5.91	6.07
		Table 17: Comparison of 2011 - 2012 and 2012 - 2013 data						

Overall, the student perception of usefulness was very similar from the first year after the introduction of the tablets to the second year.

The surveys also asked the students which applications they used the most. The students had all been supplied with credits to purchase a set of core ‘apps’ that would replicate most of the functions of a standard computing device. They also had access to specialist applications for audio and film editing, as well as subject-specific content.

Each respondent was allowed to choose more than one application and the balance of applications use showed that the biggest use of the iPads is in activities that would normally be associated with “traditional” computing devices.:

Table 18: Software applications used by students on the tablet-devices.



Qualitative Data - Teacher and Learning Support Assistant Surveys

The survey was directed to teaching staff and learning support assistants and each question had a positive answer, a negative answer and “No Change”. The results were encoded with +1, 0 and -1 and a simple mean average calculated.

Beginning with general developmental differences, all key indicators, with the exception of appropriateness of behaviour, were positive. This was reinforced with verbal comments by staff, including one who commented that a previously uncommunicative student would email them to let them know how lessons went.

	Question	Value
1	Have the students seemed more aware of their surroundings?	0.46
2	How have the students' interaction with other students been?	0.46
3	How have the student's level of communication skills progressed?	0.54
4	How have the student's level of self-expression progressed?	0.25
5	How have the students been able to generalise situations?	0.15
6	How have the students' inappropriate behaviour been?	-0.15
7	How have the students' fine motor control developed?	0.46
8	How have the students' gross motor control developed?	0.23
9	How have the students' tantrums or temper outbreaks been?	0.23
10	How have the students' overall progress been?	0.38
11	Are the students more connected with other people?	0.46
	Table 19: Attitudes to learning since the introduction of iPads	

When the data was presented for how students had performed in subject areas, there was a general correlation from how staff felt that they had performed to how the data confirmed that they had performed in English, Mathematics and Languages. The correlation was less in the other subject areas.

	Overall	En	Ma	Sc	MFL	Gg	Hi	RS
How have Autistic students performed?	0.33	0.4	0.20	0.33	-0.14	0.20	0.00	0.40
Pre-Ipad to Post-Ipad Progress Data for Autistic Students.	-0.26	0.40	0.15	-0.31	-0.18	-0.90	-0.60	-0.40
	Table 20: Staff view of Autistic Student subject progress							

Conclusions

Quantitative Data

At the subject level, the improvements for the whole school could be analysed using some of the literature research as indicators.

Subject Area	Progress of Autistic and Asperger's students before and after the introduction of iPads	Progress of Autistic and Asperger's students as compared to the whole population
English Reading	0.40	0.19
English Writing	0.15	-0.11
Mathematics	0.26	0.02
Science	-0.31	0.07
Modern Foreign Languages	-0.18	0.38
Geography	0.60	0.29
History	-0.52	-0.78
Religious Education	-0.40	-0.60
	Table 21: Progress Comparison - Autistic Students compared to whole population	

In English, one possibility here is that the focus on media creation in lessons (video, multimedia presentations) has increased the level of detail in written English work. In a piece of research conducted by the author of this study, Elliott (2005), it was found that the use of video recording of improvised or acted pieces improved the detail in the use of mise-en-scène by students when writing narrative pieces. With the 1:1 rollout, every student is given a video recording device and a suite of software to make creative media easy to use and develop.

These results would also appear to match those observed by Sheppard (2011) who showed greater improvements in reading amongst lower ability or reluctant readers when using eBooks on iPads.

This improvement in English may also explain some of the issues in other, knowledge or concept-based subjects, such as Science. Where the expression of learning content occurs through the creation by students of multimedia artefacts there is the possibility of the richness of the work being a disguise for insufficient understanding of the facts underlying the work.

With BTEC Science, the result largely depends on these produced assets but, with more traditional science courses, the understanding of the concepts is key.

With the Humanities, Geography saw similar patterns in data to Science. When one considers the similarities in content types to science, the inference could be drawn that there are similar issues.

History and Religious Education saw positive patterns in data. As we saw in the literature review, the richness of media available for History and RE gives students a wider range of sources that can make the subject matter easier for students to understand and relate to.

In Mathematics, the lack of access to one of the department's key learning tools (MyMaths), due to the lack of Adobe's Flash technology on the iPad may have impacted on the usage of the device, beyond a simple electronic textbook. One would naturally assume that the numerous calculator tools on the device would embed it within the curriculum however the requirement to use a specific range of calculators in examinations (and the exclusion of devices such as that used in the 1:1) meant that staff would expect students to also have the regulation calculator.

With Modern Foreign Languages, extensive use was made of the devices, especially as a research tool at the start of a new topic or as a voice-recording tool, to allow students to analyse their progress.

When we compare these patterns with the group being researched, whilst the group size is small compared to the overall student population, it can be seen that there seem to be clear differences between cohort groups between different subject areas. Generalisations are therefore difficult, however the picture implies a number of conclusions.

When one looks back at the research into curriculum design for Autistic students, it is clear that there must be consideration given to the way that students learn and therefore it could be argued that, in the absence of effective curriculum design, the use of iPads will not be as effective as it could be.

The data also showed that the assessment of ASD students needs to be more effective in identifying areas where they are making insufficient progress or falling behind the rate of progress of their cohort.

Answering the research question from the analysis of quantitative data, the impact of the iPads appears to be positive in English Reading, Writing, Mathematics and Geography and better than the progress difference for the whole community in English Reading, Mathematics, Science, Modern Languages and Geography.

The data for the 2008 cohort in Mathematics, as they make the transition from Key Stage 3 to 4, does affect the analysis in that subject area and, without this group, the average would be better. However the figure is still positive and marginally better than the population as a whole.

The quantitative data analysis therefore shows that the introduction of the iPads can have a positive effect on ASD students in many areas and that they benefit more than the wider community, however there are curriculum areas than need to investigate how these students can better benefit from the technology, and access to the curriculum in general.

The work of Connelly, M et al (2004) should prove invaluable in further developing staff knowledge of the Autistic Curriculum.

Uncertainty in data mainly came as students moved from year to year, rather than within a year. As the analysis for this research came from the progress from the start to the end of an academic year, this should not have impacted upon the results of the analysis, however, when one looks at the progress from the start of the research period to the end, some students whose progress may have dipped in the second year still made good overall progress.

A second area of uncertainty in the data came from the transition at the Key Stage 3 (levels) to Key Stage 4 (grades) boundary. This research used the DfE Standards Site unified point scores table (Appendix B). Whilst the grade equivalence scale should allow for a direct translation, in reality a level 6 (39 points) is considered much lower than a grade C (40 points).

If we look at this transition boundary in more detail, the overlap between Level 6, Level 7 and the boundaries for Grade C, it is clear that any research project that spans this area will encounter difficulties. As already states, this research looked at the progress within a year, rather than across years however the reader should be aware of an overall uncertainty in the Year 9 to 10 data.

A better methodology for the identification of ASD students, that does not rely on individual interview or observation would greatly benefit the education of such students, as research makes clear that teachers must adapt the curriculum to suit these students, just as we may have adapted lessons after the identification of students as Visual, Auditory or Kinaesthetic learners.

Charman and Gotham (2013) discuss the progress made in the diagnosis of ASD and the use of datasets to produce diagnostic instruments but even they conclude that the lack of a proper test for ASD and the dependency on behavioural analysis makes screening difficult.

> *“However, as with screening tools, diagnostic instruments are often limited by inadequate power to correctly identify individuals with and without ASD. Furthermore, the estimates of such performance validity for each particular measure are necessarily limited by the absence of an absolute test for ASD, and as such are influenced by clinical experience in diagnosing*

ASD, training and experience in using the diagnostic measure and evolution within the field in terms of what is recognised and labelled "ASD."

Qualitative Data

Survey of Student Attitudes to IPads

Looking at the student opinions as to the usefulness of the iPads in subject areas, when one looks at the summary data and considers student comments, there is no direct comparison that can be made between the usefulness that the students associated the devices as having in each subject area when compared to the actual difference that the iPads made.

	Overall	En	Ma	Sc	MFL	Gg	Hi	RS
Average Usefulness Score	6.66	6.52	4.89	6.34	6.10	5.85	6.12	6.78
All Student Progress Data Comparison	-0.13	0.23	0.24	-0.38	-0.56	-0.90	0.27	0.20
ASD Student Progress Data Comparison	-0.04	0.28	0.26	-0.31	-0.18	0.60	-0.52	-0.40
	Table 22: Student usefulness score against iPad progress.							

Students' perceptions of usefulness (ability to research information, present findings in documents, use subject specific applications and communicate via email and other messaging services) do not appear to directly correlate to an increase in levels.

Equally, subject areas that were regarded as making exemplary use of the devices for internet research and the presentation of information, and where students expressed high satisfaction, such as MFL and Science, the difference between pre and post iPad introduction is actually negative.

One hypothesis, that would need to be researched further, is that, whilst students have become more skilled at the gathering, interpretation and presentation of information, assessment methodologies have continued to focus on the ability to memorise and use conceptual material and therefore a lower focus on these more

traditional skills in lessons has led to a fall in the rate of progress as measured by the assessment materials used.

This would be borne out by the data from BTEC Science classes where their progress has been markedly better than the average and where the new skill-set would have the most value to their progress.

In the second year, the data showed a general positive attitude to the devices however the use of incompatible learning resources by some subject areas meant that in those areas, students felt that the devices were not as useful as they could have been otherwise.

Use of applications were as would be expected for a more standard computing device, with Word Processing and Multimedia Presentations still the mainstay of use.

Survey of Staff as to the Impact on Autistic Students

The survey results largely follow the pattern that the literature review would suggest. Staff observed a strong benefit for Autistic students in the areas of communication, interaction with other students and general connection to other people.

It was interesting to see that the staff also considered that there was a strong benefit in fine motor control. This was an unintended benefit of the touch-screen nature of the devices however when one considers the precision needed to interact with the graphical interface, it is perhaps less surprising than one would consider at first.

Staff reported that inappropriate behaviour had increased amongst the group being studied, however this was not further defined. Certainly observation of these students showed off-task activities, mainly due to entertainment apps being used in school time. It is therefore important to consider how students access applications on iPads and, for those who find focus difficult, parental controls or mobile management methodologies may be useful.

When looking at the views of staff on the progress in specific subject areas, there was a good correlation with staff opinion in English and Mathematics and, although this represented a negative effect, in Modern Languages as well,

in Science, Geography, History and Religious Studies, staff felt that the devices had a positive effect and yet the data shows otherwise. It is clear that the iPads are assisting students in the development of different skills to those that would necessarily be measured in the assessment materials. Observationally, students had become far better at using research to show evidence of learning in written materials, however this does not necessarily mean that the learning has become embedded.

A wonderfully descriptive statement was made by a member of staff about one ASD student who wanted to comment beyond the survey:

> *“They (The Autistic student) uses theirs to email me, telling me I'm funny and asking me to come and look at their work. They also sends me pictures that they thinks I'll like and ones of their dog.*

Bearing in mind that their statement says they do not understand humour or empathy, I think the iPad has given them an implement they can show they do feel and understand these.

They would not have this tool at home due to family circumstance and being able to email me during the school day to see their work or when they have a problem has been a real bonus for them, though perhaps a little stalkeresque for me!!"

This was a common thread amongst the learning support staff and showed that, whatever the effect on curriculum progress, the benefits on wider skills were clear to see,

This above comment on the impact of the iPad on ASD students is interesting in the light of Baron-Cohen's comments (2005) where it is stated that:

"My proposal is this: that what drives a non-autistic person to be interested in another self (not just their own) is empathy. And that what drives a person with autism (be it classic autism or the milder Asperger Syndrome) to be relatively disinterested in other selves, and primarily focused on their own interests, knowledge, goals or projects, is an impairment in empathy."

Could the iPads offer a method of overcoming this empathy-deficit? There certainly needs to be more development on using this to overcome one weakness that was still apparent in their curriculum development, and forecast by Baron-Cohen (2005) who stated:

"Typically, they pursued their own intellectual interests to high levels, such as learning books of facts, or studying the movement of the sun and shadows around their bedroom, or attempting to breed tropical fish, becoming very knowledgeable on these subjects. But many also failed to hand in the required schoolwork, so that they were failing in some academic subjects. Having no drive to please the teacher, they simply followed their own interests, rather than the whole curriculum."

Leach and Birnie (2006) comment on the use of electronic communication in assisting (Further and Higher Education) students with Asperger's by saying that:

> *"Utilising electronic support for communication not in real time – such as a discussion on WebCT and encouragement for all students to write something about themselves - would provide an Asperger's student with an effective means of social intercourse, which sitting in your office in a tutorial will not."*

In terms of accuracy of data, the surveys on student opinion as to the usefulness of further study should be given to interviews with students on the Autistic Spectrum and their parents to ascertain first-hand accounts of the benefits of the devices outside of the school environment.

Staff reported such students being far more ready to communicate with them about the lessons and their progress and it may be that these benefits are more valuable than any curriculum development.

The work of Clark (2009) on the use of Life Stories for understanding ASD students should be used as a basis for broadening the study to better describe the experiences of the students, rather than relying on the opinions of others.

Because of the grouping of many of the students into similar streams or sets, the number of staff responding to the survey was lower than one might at first expect, with 25% or all teaching and learning support staff responding, there may be errors in the survey data due any subjective bias of the respondents, however those who responded were strong in their feelings of the iPads benefit.

Overall Conclusions

In this research project, the aim was to answer the question “What educational benefits do offer to students with Asperger’s Syndrome and Autistic Spectrum Disorders? “.

The data shows that the use of personal iPads has an overall positive effect for ASD students, when compared to the general population, for most subject areas, with the exception of History and Religious Studies.

The survey of teaching and support staff also showed that there were other benefits to the devices, as would be expected from other research, with communication and fine-motor skills being areas of particular benefit.

The main curriculum benefits are in the areas of literacy (reading) and numeracy, as well as general thinking and communication skills. Writing still sees a positive improvement, however this is not as great as the general population.

From the data collected, there is wide variation between individual students and it is clear from conversations with staff that there are other students who should have been included within the dataset but where parents do not wish a diagnosis to be sought, due to the stigma associated with Autism and Asperger’s Syndrome, or where students have not been identified.

Better identification of assessment data for ASD students would also allow more targeted use of the iPads, through the selection of specialist apps or curriculum methodologies to ensure better use in those areas where progression was not as great as it could have been.

From the qualitative analysis, it can be seen that the overall impression was positive. Students were largely satisfied that the devices had a positive usefulness in lessons and staff reported that the ability of students to access a wide range of sources in lessons was of great benefit.

What was interesting that, far from being the content consumption devices that many people forecast (and comment on in the media) the iPads were used extensively by the students for the production of work.

From the point of view of ASD students, staff reported positive benefits in most key indicators and informal discussion with learning support assistants reported that the students were far more confident in communicating success and difficulties with them.

In the second year of the implementation, the researcher regularly taught eleven of the fifteen students being studies and it was clear that the iPads had become integral to their working methods in class, using them for research, presentation of work, email (and other forms of communication) as well as a recording device, for example photographing notes on the whiteboard, activities being undertaken or other situations, to make recall later more easy.

The iPads had clear benefits in allowing the students to become more independent learners, taking control of the gathering and presentation of content and were invaluable as a levelling tool, giving a way for the research group to communicate with their peers and teaching staff to take learning beyond the classroom.

The iPads also gave the students a tool that allowed them to individualise their learning and access non-traditional textual materials to gather information from. This gave added value to the devices as they gave a vehicle to research the “special interest” that many of them had. However, this might then allow distraction away from the tasks at hand and affect progress.

To this end, the findings of this research project would largely concur with the body of research on the benefits of IT for ASD students, with reference to developmental measurements but broadens the research to show that, without the specific measures that the literature proposes for the Autistic Curriculum, progress in subject areas is not guaranteed to have positive effects but, where it does, iPads can have very positive results.

The research would therefore recommend that there needs to be specific guidance developed on the use of iPads in 1:1 implementations for ASD students, taking the work of Connelly, M et al (2004) as a foundation. It may be beneficial to further investigate the Apps that the students with ASD chose to put on their iPads and relate these to the headings in the Emotional Toolkit described by Attwood (2007,159-169) and to the curriculum being studied.

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Appendix A:

The RED FLAGS for autism

Communication concerns
does not respond to his/her name
cannot tell me what s/he wants
language is delayed
doesn't follow directions
appears deaf at times
seems to hear sometimes but not at others
doesn't point or wave goodbye
used to say a few words, but now doesn't.

Social concerns
doesn't smile socially
seems to prefer to play alone
gets things for him/herself
is very independent
does things 'early'
has poor eye contact
is in his/her own world
tunes us out
is not interested in other students.

Behavioural concerns
tantrums
is hyperactive/uncooperative/oppositional
doesn't know how to play with toys
gets stuck on things regularly
toe walks
has unusual attachments to toys
lines things up
is oversensitive to certain textures or sounds
has odd movement patterns.

Absolute indications for immediate further evaluation
no babbling by 12 months
no gesturing (pointing, waving, bye-bye, etc) by 12 months
no single words by 16 months
no two-word spontaneous (not just echolalic) phrases by 24 months
ANY loss of ANY language or social skills at ANY age.

Reproduced from Filipek, P. A. et al (1999).

Appendix B:

National Curriculum Levels and Grades Equivalences

F1	1.0	4c	25.0	Ca	42.0
F2	3.0	Ec	26.0	7c	43.0
F3	5.0	4	27.0	Bc	44.0
1c	7.0	4b	27.0	7	45.0
1b	9.0	E	28.0	7b	45.0
1	9.0	Eb	28.0	B	46.0
1a	11.0	4a	29.0	Bb	46.0
2c	13.0	Ea	30.0	7a	47.0
Gc	14.0	5c	31.0	8c	49.0
2	15.0	Dc	32.0	Ac	50.0
2b	15.0	5	33.0	8	51.0
G	16.0	5b	33.0	8b	51.0
Gb	16.0	D	34.0	A	52.0
2a	17.0	Db	34.0	Ab	52.0
Ga	18.0	5a	35.0	8a	53.0
3c	19.0	Da	36.0	Aa	54.0
Fc	20.0	6c	37.0	A*c	56.0
3	21.0	Cc	38.0	A*	58.0
3b	21.0	6	39.0	A*a	60.0
F	22.0	6b	39.0		
Fb	22.0	C	40.0		
3a	23.0	Cb	40.0		
Fa	24.0	6a	41.0		

Department of Education, School Performance Tables http://www.education.gov.uk

Appendix C:
SIMS Data Set for Quantitative Analysis

Unique Pupil Number
Admission Number
First Name
Last Name
Gender
Year of Intake
National Curriculum Year
Free School Meals
English as Another Language (EAL)
Home Language
NFER CAT3 Verbal Reasoning (Standardised Score)
NFER CAT3 Non-Verbal Reasoning (Standardised Score)
NFER CAT3 Quantitative Reasoning (Standardised Score)
Special Need Type
Special Need Status
Autism Flag
Subject Level (Start of 2010)
Subject Level (End of 2010)
Subject Level (Start of 2011)
Subject Level (End of 2011)

(English Language, Literature, Reading, Writing, Mathematics, Science, Biology, Chemistry, Physics, Geography, History, Religious Studies, Modern Foreign Languages)

The UPN / Admission numbers were used to link datasets together and then to anonymise the data, allowing for removal of the student names.

Further anonymisation was achieved by exchanging the UPD/Admission Number for a simple reference number. In this way, the data files could not be traced back to any individual student.

Appendix D:
Survey of student attitudes to iPads in curriculum areas

Year Group (7,8,9,10,11)
Gender (Male,Female)
Overall, How useful have you found the iPads for your learning (Scale 1-9)
How useful have you found the iPad in English (Scale 1-9)
How useful have you found the iPad in Mathematics (Scale 1-9)
How useful have you found the iPad in Science (Scale 1-9)
How useful have you found the iPad in Modern Foreign Languages (Scale 1-9)
How useful have you found the iPad in Geography (Scale 1-9)
How useful have you found the iPad in History (Scale 1-9)
How useful have you found the iPad in Religious Studies (Scale 1-9)
Which of the following applications do you find useful for learning in school? (list)
Which of the following applications do you find useful for learning at home? (list)

Scale 1-9 (Single choice radio button)

Not very useful 1
Extremely Useful 9

Applications List (Multiple choice tick list)

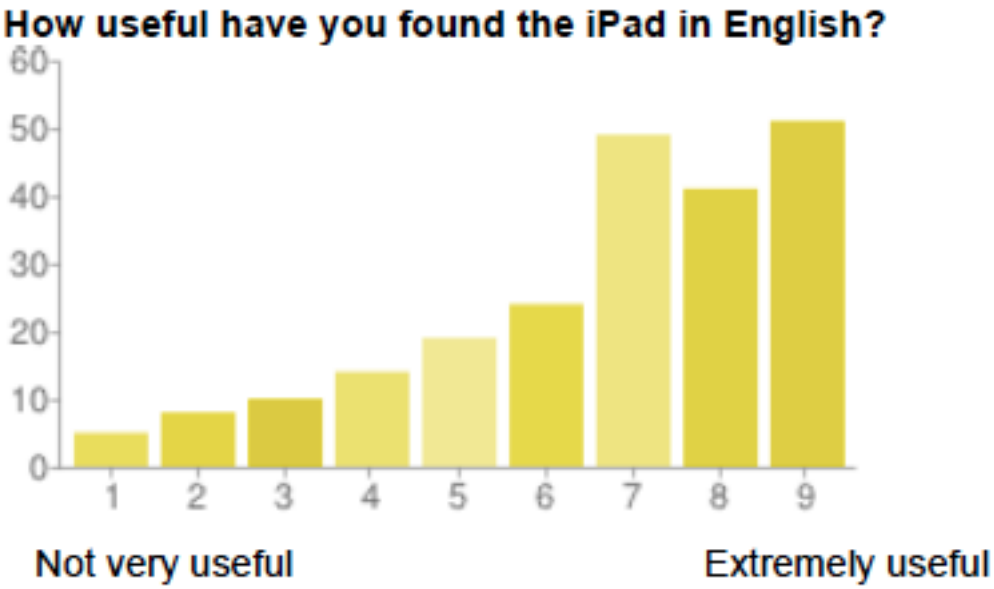
Word Processing
Spreadsheets
Multimedia Presentations
Movie Editing
Audio Editing
Animation
Comic Production
Virtual Whiteboard Application
Mind Mapping
Social Media (and other communication applications)

Appendix E:

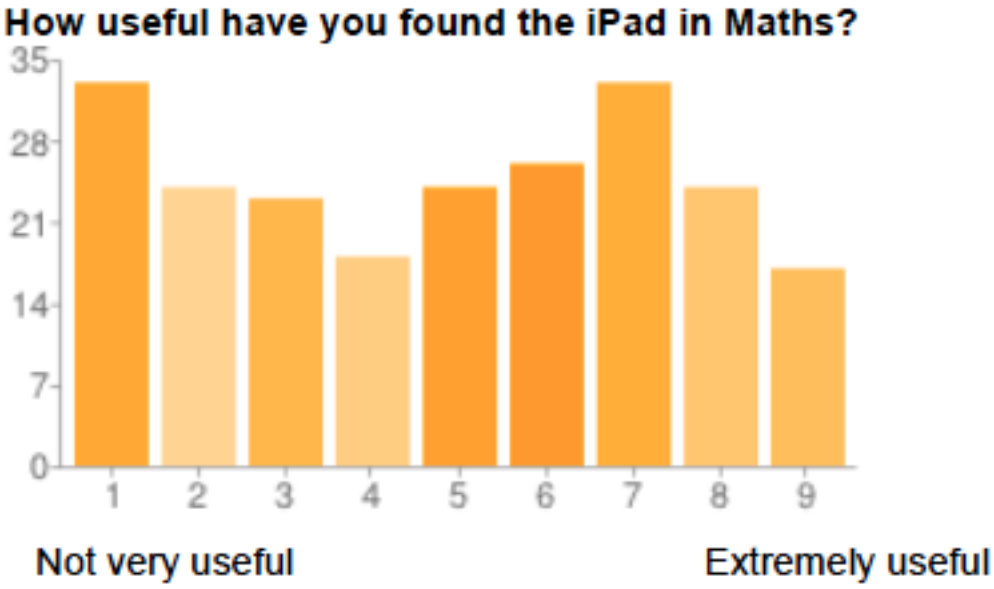
Survey of student attitudes to iPads in curriculum areas

The following graphs show the balance of answers from students as to the usefulness in each curriculum area. Note that several subjects showed peaks of students who felt the devices had little use and those who felt that they had been extremely useful. Further studies on which students do not find the devices useful and why would benefit future implementations.

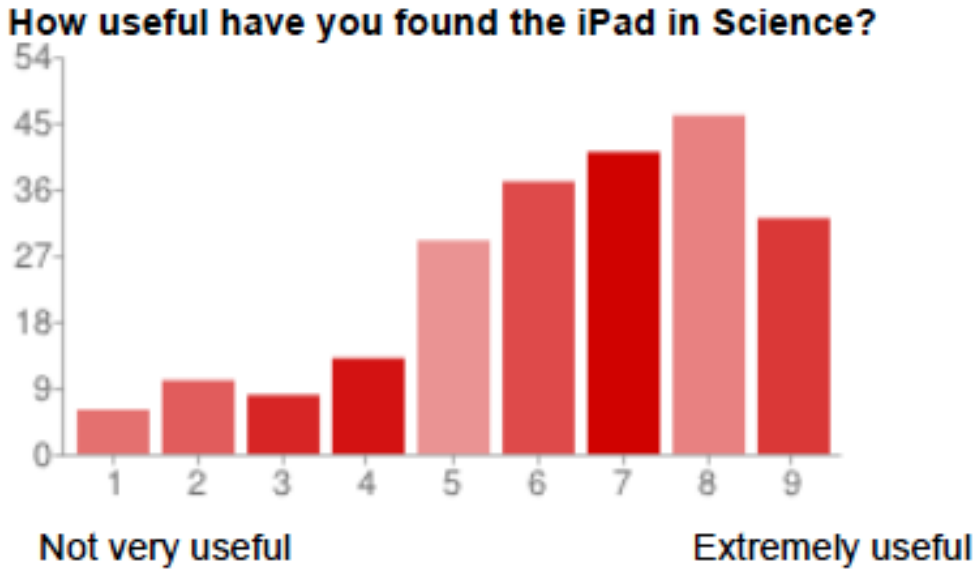
English Language and Literature:



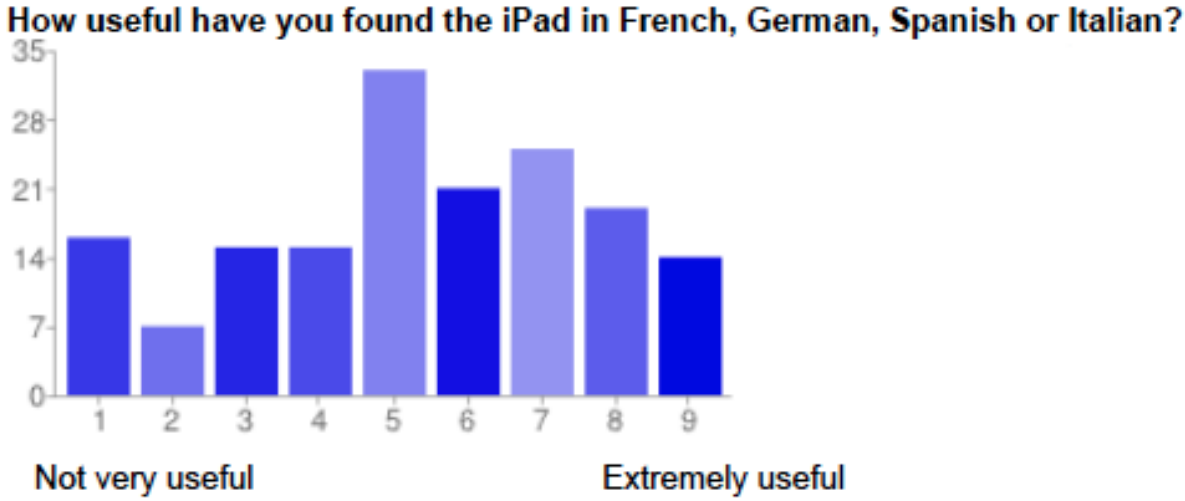
Mathematics



Sciences



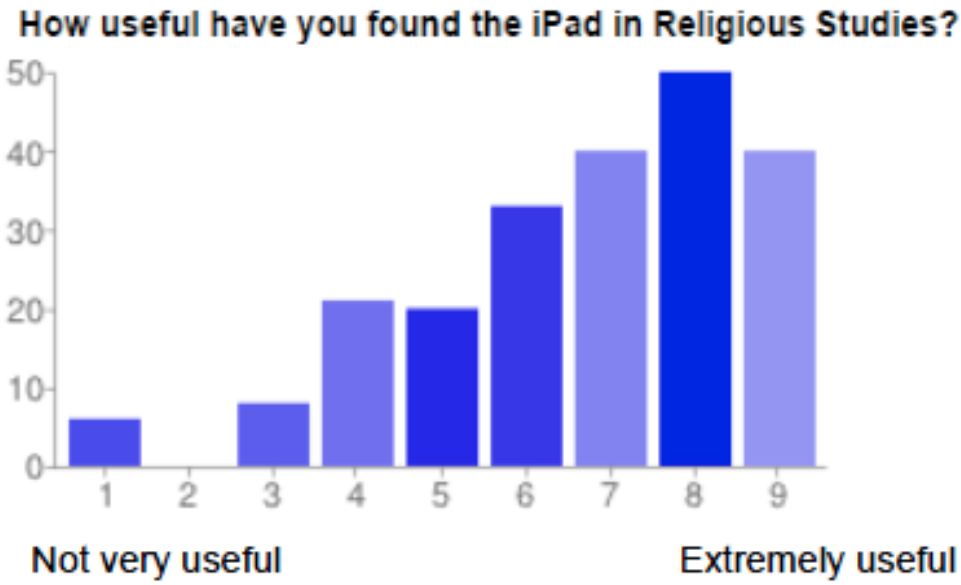
Modern Languages



Geography

History

Religious Studies



Appendix F:
Survey of Teachers and Learning Support Assistants

1. Have the students seemed more aware of their surroundings?
2. How have the students' interaction with other students been?
3. How have the student's level of communication skills progressed?
4. How have the student's level of self-expression progressed?
5. How have the students been able to generalise situations?
6. How have the students' inappropriate behaviour been?
7. How have the students' fine motor control developed?
8. How have the students' gross motor control developed?
9. How have the students' tantrums or temper outbreaks been?
10. How have the students' overall progress been?
11. Are the students more connected with other people?
12. How have the students performed overall
13. How have the students performed in English
14. How have the students performed in Mathematics
15. How have the students performed in Science
16. How have the students performed in Modern Languages
17. How have the students performed in Geography
18. How have the students performed in History
19. How have the students performed in Religious Studies

To each question, the respondent had a choice of “Better Progress”, “No Change”, “Worse Progress”