Abstract

Many studies have shown that the use of technology in the classroom may influence pupil engagement. Despite the recent widespread use of tablet technology, however, very little research has been carried out into their use in a primary school setting. We investigated the use of tablet computers, specifically Apple's 'iPad', in an upper primary school setting with regard to children's engagement. Cognitive, emotional and general engagement was higher in lessons based on iPads than those which were not. There was no difference in behavioral engagement. Of particular significance was the increase in engagement seen in boys, which resulted in their engagement levels increasing to levels comparable to those seen in girls. These findings suggest that tablet technology has potential as a tool in the classroom setting.

Keywords: Engagement, gender, iPAD, tablet, technology, touch-screen

Introduction

The importance of education to be engaging for learners is well understood (Finn & Rock, 1997; Kirsch et al., 2002; Willms, 2003) and for many years it has been associated with academic success (Bloom, 1976). Engagement positively correlates with several factors, including school attendance rates (Voelkl, 1995), achievement (Connell, Spencer & Aber, 1994) a sense of belonging (Goodenow, 1993), and confidence of pupils with regard to achieving learning outcomes (Schunk & Zimmerman, 1994).

Defining Engagement

Engagement of learners within schools encompasses meaningful involvement in the learning process. Precise definitions vary, from those emphasizing a holistic educational experience to approaches emphasizing complex cognitive, behavioural, and emotional markers of engagement and their impact in a task based setting (Skinner & Belmont, 1993). In this model, behavioural engagement centers round the concept of participation, (social, academic or extracurricular), whereas emotional engagement refers to affective reactions (positive or negative) to those sharing the school environment. Cognitive engagement involves the intellectual faculties necessary to comprehend new information and skills (Fredricks et al., 2005). More recently, some studies have challenged the traditional 'approaches to learning' and engagement and have focused instead on the idea of alienation and engagement (Case, 2008) although the majority of these studies have principally focused on the higher education system. Jacobsen et al (2002) describe a critical enquiry based approach to the use of technology in learning which echoes our own approach. They emphasize the importance of empowering educators and focus on the 'task' rather than on the technology.

We chose to adopt a working definition of engagement drawing upon the discussions above. Based on Kearney & Perkins (2011) we therefore define engagement as: The emotional, behavioral, and cognitive evidence of students being actively involved in the academic experience.

Measuring engagement

Attempts to measure engagement utilise several procedures, including student questionnaires and teacher observations. Although used extensively, measures which utilize self-reporting are subject to bias and are dependent on the pupils' own ability to accurately determine their own engagement levels (Assor & Connell, 1992). In addition, asking classroom teachers to complete observations can be problematic, as systematic observations require the complete attention of the observer. A teacher involved in teaching a class will not be able to devote their entire attention to observing. For this reason, observational studies using neutral observers may be preferable, although further insight may be gained

by teachers' observations. Chapman (2003) suggests that measurement of student engagement in the classroom should examine cognitive, affective, and behavioural aspects of engagement.

Gender differences in attainment & engagement

The gender gap in education attainment is well documented, with boys falling behind girls in examinations. The Department for Education and Skills began recording a gender gap with regards to educational attainment in 1988. Since 1995 this gap has remained roughly constant at around 10% in favour of girls (Department for Education, 2003). Many factors are thought to contribute towards this discrepancy (Jackson, Moore & Leon, 2010).

In concordance with previous studies, Fredricks, Blumenfeld & Paris (2004) found that girls reported significantly higher engagement than boys in schools. Not only did they find a difference in general engagement, but in all three sub-components (behavioural, emotional, and cognitive). Various reasons have been suggested for this, including biological differences, gender stereotyping, lack of role models, curricular design (Cortis and Newmarch, 2000), staff motivation (Atkinson, 2000), involvement of parents (Gonida et al, 2009), and home circumstances (Johnson et al, 2007). It may be that the present educational status-quo is inherently uninteresting to boys, and is not engaging them, thus resulting in poor academic performance.

Unfortunately, the knowledge gained over the past two decades on gender differences has rarely been applied systematically to the classroom environment, often to the detriment of boys' learning (Kovalik, 2008). A recent study specifically looking at Scottish educational policy suggested that within the broader inclusion agenda, there is a risk that gender issues become overlooked (Forde et al., 2006). Of the multitude of factors which may potentially influence engagement, one factor is the use of technology in schools.

Technology in schools and engagement

It has been suggested that, used effectively, technology can be a factor which increases pupil motivation and engagement. Wishart & Blease (1999) found an improvement in teaching and learning where technology was used in various ways. Thus, the idea that technology may be used to promote 'active learning' and raise engagement levels in the classroom is not new (Bonwell & Eison, 1991). A recent second-order meta analysis spanning 40 years of research found that technology had a significant impact on education to the effect that 'the average student in a classroom where technology is used will perform 12 percentile points higher than the average student in the traditional setting that does not use technology to enhance the learning process' (Tamin et al, 2011). However, too often, the perception of

technology in education is that of novelty, rather than technological innovations becoming effectively embedded within the curriculum.

The impact of technology on teaching in many different subjects has been widely researched over the past couple of decades. Looking at general motivation and engagement, Arrowood & Overall (2004), Chung & Walsh (2006) and Schmid, Miodrag & DiFrancesco (2008) all reported that computers could be useful in promoting engagement and motivation in young children in the teaching of handwriting and literacy. Price et al. (2003) focused on collaboration and various others have demonstrated that the use of technology in teaching and learning is associated with improved problem solving and language skills (reviewed in Couse and Chen 2010).

Other examples of the use of technology in teaching that have been widely debated are i) the use of 'whiteboards' (Beeland, 2002). ii) desktop virtual reality (Lee, Wong & Fung, 2010) and (iii) with particular reference to this study, work on enthusiasm associated with mathematical achievement (Barkatsas, Kasimatis & Gialamas (2009). However, there is some skepticism concerning the benefits of technology in the classroom, particularly in its current form (Plumm, 2008). Of particular concern is the gap between the school environment, where access to technology is relatively limited, and the child's 'outside' experience where mobile devices are causing a revolution in the way in which information is accessed.

Mobile Learning and Tablet Computers

There has been a distinct move in the past few years from the use of desk and notebook computers to tablet devices and this in part has fueled the concept of 'mobile learning'. Masrom & Ismali (2010) assert mobile learning offers a diverse range of activities, and promotes the 'affective forms of motivation characterized among others; control, ownership, fun and communication' (Jones et al., 2007; Sharples, 2007). Tablet computers are touch-screen based and heavily feature applications or 'apps', programs which allow the user to perform a multiplicity of tasks from playing games, editing photos, trading shares, to a whole variety of apps specifically designed for the educational market. Internet browsing is another key feature of these devices as is media consumption and social networking capabilities. Various platforms exist including the Apple and Android systems. While the use of tablet computer technology in education has been investigated to a limited extent, the majority of these studies focus on higher education and in particular on information technology based subjects (Willis & Miertschin, 2004; Frolik & Zorn, 2004). There have, however, been some studies relating to the iPod/Pad specifically. Evenstuen et al (2010) examined the fundamental skill of note-taking using an iPad and whilst this is a different aspect from the current study it shows that the potential of the device can be considered from

many different angles. There are, though, comparatively few recent studies on the use of touch screen technology in school settings, possibly due to the relatively recent widespread availability.

Rationale for Current Study

In light of the literature discussed above, we felt there was a need to investigate the impact of the use the iPad in a classroom setting on pupil engagement. This is especially relevant in Scotland, as the Scottish government has recently embarked on creating a 'Technologies for Learning' strategy (Scotland's Digital Future, 2011), which aims to 'embed the transformational potential of technologies for learning in a proactive, integrated and sustainable manner for the benefit of Scotland's learners'. It is therefore important to investigate how adoption of this technology impacts upon engagement within the classroom setting. We decided to consider iPads separately from other mobile personal devices and were especially interested in the 'tablet' device since it sits somewhere between the laptop and the iPod sized device. The tablet computer seemed to us to offer a unique in terms of portability as well as having fewer limitations than the smaller devices (in terms of lack of connectivity to outside devices and lack of word processing ability). The school we were working with was not in the position to offer 1:1 deployment of laptops but had the opportunity to do this with iPads. The findings of this study may well be applicable to other technologies and this is an area that requires further investigation. We were also particularly interested in any gender specific differences in engagement in this setting.

Methods

Setting

The study was conducted in Cedars School of Excellence in Greenock, Scotland, a private school that had deployed a one iPad per child policy 7 months prior to data being collected. All the students had been using iPads in the classroom for approximately 7 months before the study took place. Children who were aged 8 or older were able to take the devices home.

We specifically chose to wait until this time period had elapsed before carrying out the study as we did not want to bias the results with the novel use of technology transiently increasing engagement. Two classrooms were used for the observations which were composite classes of primary 4-5, and 6-7 (aged 8-11 years old).

Design

The study was cross sectional in design, where systematic observations of two primary classes were carried out in lessons using the iPad, and without. Two classroom teachers were asked to complete

two lessons based upon the experiences and outcomes in a Curriculum for Excellence with their class, one utilizing 1:1 iPad deployment, and the other based upon traditional classroom teaching style, in which the technology was not utilized. The same children were in both lessons for each teacher. Three researchers observed each child in each lesson for 30 minutes (60 min in total per child) and completed the Classroom Engagement Questionnaire (see below). Results from these observations were compared using within groups t-tests.

The study was designed to look at two key aspects of the curriculum, geometrical and linguistic studies. Four lessons were observed in total; two iPad and two non-iPad based sessions. These lessons were designed based on a Curriculum for Excellence outcomes. Tables 1a and 1b outlines each session.

Table 1a: Geometry-Based Lessons

Lesson Outline	Curriculum for Excellence Experiences & Outcomes*
Session 1: Geometry (Non iPad). This lesson involved pupils designing tiled patterns using a variety of different shapes. Within the session pupils used traditional tools such as rulers, pencils and paper as well as a variety of colouring implements and were free to approach the design as they saw fit.	Having explored a range of 2D shapes, I can use mathematical language to describe their properties, and, through practical activities, can show my understanding of these properties. **MTH 2-16a** I can draw 2D shapes using an appropriate range of traditional methods and efficient use of resources. **MTH 2-16c** I can apply my understanding of symmetry and tiling for a range of 2D shapes to create and complete symmetrical pictures and patterns. **MTH 2-19a / MTH 3-19a**
Session 2: Geometry (iPad). The outcome of this lesson was the design of a logo for a branded product. Pupils used a variety of 'apps' as well as the internet and word processing tools if desired to use differing shapes to produce a logo. Again pupils were given freedom to use whichever apps they deemed appropriate.	Having explored a range of 2D shapes, I can use mathematical language to describe their properties, and, through practical activities, can show my understanding of these properties. **MTH 2-16a** I can draw 2D shapes using an appropriate range of digital methods and efficient use of resources. **MTH 2-16c** I can apply my understanding of symmetry and tiling for a range of 2D shapes to create and complete symmetrical pictures and patterns. **MTH 2-19a / MTH 3-19a** I can develop and communicate my ideas, demonstrating imagination and presenting at least one possible solution to a design problem. **EXA 2-06a** I can explore and experiment with the features and functions of different apps and I can use what I learn to support and enhance my learning in this design task. **TCH 1-04a / TCH 2-04a** I can use search facilities of the internet

	to access and retrieve information effectively and efficiently. **TCH 2-03b**

*Curriculum for Excellence Experiences & Outcomes which are relevant to this class (as defined by Education Scotland). Each abbreviation (eg TCH 1-04a) denotes a specific experience or outcome from the curriculum that has been selected by the teacher for achievement or experience within this class.

Table 1b: Linguistic-based sessions

Lesson Outline	Curriculum for Excellence Experiences & Outcomes*
Session 3: Linguistic (Non iPad). Children brainstormed the topic 'I know I am at home when...' to generate ideas on which to base a piece of poetry. They then individually wrote a 'senses based' poem.	When listening and talking with others for brainstorming activities, I can: · share information, experiences and opinions · explain ideas · listen attentively to others and comment appropriately · clarify points by asking questions or by asking others to say more. **LIT 2-09a** Throughout the writing process, I can check that my writing makes sense and meets its purpose. **LIT 2-23a** I can convey information, describe events and emotions, explain processes or combine ideas effectively within the structure of a poem. **LIT 2-28a** I am learning to use language and style in a way which engages and/or influences my reader. **ENG 2-27a** By considering the type of text I am creating (a poem), I can select ideas and relevant information, organise these in an appropriate way for my purpose and use suitable vocabulary for my audience. **LIT 2-26a**
Session 4: Linguistic (iPad). Children used word processing packages as well as apps to type poems they were writing into their devices. These were recorded on 'Garage band' and atmospheric tracks recorded over these as the children wished	I consider the impact that layout and presentation will have and can combine lettering, graphics and other features to engage my reader. **LIT 2-24a** Throughout the writing process, I can check that my writing makes sense and meets its purpose. **LIT 2-23a** I can convey information, describe events and emotions, explain processes or combine ideas effectively within the structure of a poem, taking advantage of the opportunities offered by ICT **LIT 2-28a** I am learning to use language and style in a way which engages and/or influences my reader.

	ENG 2-27a I can digitally create, capture and manipulate sounds, text and images to communicate experiences, ideas and information in creative and engaging ways. **TCH 1-04b / TCH 2-04b** I explore and experiment with the features and functions of computer technology and I can use what I learn to support and enhance my learning in this poetry task. **TCH 1-04a / TCH 2-04a**

*Curriculum for Excellence Experiences & Outcomes which are relevant to this class (as defined by Education Scotland). Each abbreviation (eg TCH 1-04a) denotes a specific experience or outcome from the curriculum that has been selected by the teacher for achievement or experience within this class.

In this study, the lessons using iPad or not were not designed to be exactly alike. This was intrinsic to the study design. An alternative methodology would be to study virtually duplicate lessons e.g. writing an essay or completing arithmetic on the iPad versus in a jotter. While undoubtedly there may be some merit in this approach we felt that this would negate to examine the transformatory effect of the iPad on the education process i.e. lessons which are iPad based and non iPad based do not have the same foundation although the learning outcomes may be similar.

Ethical Approval

The study was approved by University of Glasgow, School of Education ethics committee. All participants, as well as their parents, provided written consent.

Participants

A total of 28 pupils were observed in the study. Table 2 details participant demographics.

Table 2: Participant demographics

	Number	Primary	Age (M, SD)
Males	18	P 4/5=10, P 6/7=8	8.6 (0.63)
Females	10	P 4/5=5, P 6/7=5	10.6 (0.65)
Total	28	28	9.5 (1.2)

Procedure

Parents of children in both classes were given an information sheet and asked to give consent for their child to be observed. In addition, classroom teacher obtained written consent from children. One child did not wish to participate. Teachers were instructed to perform an everyday lesson as they would if not being observed, half of the day using the iPad, and half using traditional teaching methods. 3 observers joined the class, and observed each child for 30 minutes using the iPad, and 30 minutes being taught traditionally. Each observer was randomly allocated one third of each class to observe for each type of lesson. The observers then monitored each child for 30 minutes in that setting. Observers scored each child on each item of the Classroom Engagement Questionnaire for both sessions. Comparisons across the two conditions were made.

Prior to the study, the observers were instructed in the theoretical underpinnings of the measure (i.e. engagement theory) and in the construction of the questionnaire using this theory. They were briefed on how to evaluate each aspect of the engagement model that are captured in each question (e.g. for ‘child loses interest during tasks’, one of the measures of cognitive engagement, observers were asked to

gauge the level of interest that was generally seen in the class at the time, and to compare their participant's interest to that experienced by their classmates. They were also briefed on what signs of 'interest' to look for, such as focusing visually on the materials associated with the task, physically interacting with the task, and being able to ignore distractions external to the task).

Checklist Development

Engagement was measured using a 'Classroom Engagement Checklist' developed by the authors. As rationalised above, observational studies using neutral observers are the optimal means of assessing engagement (Majoka, Dad & Mahmood, 2010), and are often used in addition to students' reported levels (Chapman, 2003).

Age, gender, and class were each noted at the beginning of the observations. The Classroom Engagement Checklist was constructed with reference to Engagement Theory (Shneiderman, 1994, 1998; Shneiderman et al., 1995; Kearsley & Shneiderman, 1997). Engagement Theory is underpinned by the understanding that meaningful engagement in learning takes place through interpersonal interaction, and learning through worthwhile tasks. In developing the checklist, the working definition of engagement outlined above was utilized. The checklist was composed of three subscales, measuring emotional (e.g. 'Child appears enthusiastic about tasks'), cognitive (e.g. 'Child appears to concentrate well on tasks'), and behavioural ('Child interacts appropriately with classmates') engagement, as well as an overall engagement score. The scale employed 17 five-point Likert scale observational statements. Five questions related to emotional engagement, six related to cognitive and six related to behavioural engagement. Scores on questions were added to give an overall score for each construct (with a maximum of 30 for cognitive and behavioural engagement, and a maximum of 25 for emotional engagement). All scores were added together to give an overall measure of engagement. Initial drafts of the questionnaire were piloted with two primary school teachers familiar with engagement theory, with their recommendations and comments taken into consideration in the final draft of the questionnaire. The scale had good to moderate reliability, with Cronbach's α values of .56 (Emotional Engagement), .82 (Cognitive Engagement), and .55 (Behavioural Engagement), for each of the subscales.

Analysis

Mean engagement and subscale scores were compared between the experimental (with iPad) and control (without iPad) conditions. In addition, given previous research suggesting gender differences in engagement and classroom achievement, gender differences were also analysed.

Results

Significant differences were found between iPad and control conditions, with students scoring higher on overall engagement and on cognitive and emotional engagement when using the iPad, but not behavioural engagement. These are illustrated in table 3.

Table 3: Engagement (t-tests)

***t*-tests**	**Without iPad (Mean)**	**With iPad (Mean)**	***t*-value (df)**	**p-value**	**Effect size (Cohen's d)**
Behavioural Engagement	22.7 (3.3)	23 (3.6)	-.453 (27)	.654	0.087
Cognitive Engagement	21.2 (4.9)	25 (3.8)	-3.1 (27)	.004**	0.87
Emotional Engagement	17.6 (3.1)	19.5 (2.4)	-2.69 (27)	.012*	0.69
Overall Engagement	61.5 (9.6)	67.5 (7.9)	-2.62 (27)	.014*	0.68

*p.<.05, **p.<.01

In addition, analysis by gender revealed that the pattern of significant differences observed in the overall analysis remained in males, but there were no significant differences between the conditions for females' engagement. These are illustrated in table 4.

Table 4: Gender differences in engagement (t-tests)

T-tests	Without iPad (Mean)	With iPad (Mean)	*t*-value (df)	p-value	Effect size (Cohen's d)
Male Behavioural Engagement	22.2 (3.7)	23.3 (3.3)	-1.34 (17)	.199	0.31
Female Behavioural Engagement	23.7 (4.1)	22.6 (4.1)	.892 (9)	.396	0.27
Male Cognitive Engagement	20.3 (5.4)	25.1 (2.8)	-2.95 (17)	.009**	0.9
Female Cognitive Engagement	22.8 (3.6)	24.8 (5.3)	-1.21 (9)	.259	0.44
Male Emotional Engagement	17.1 (3.6)	19.6 (2.1)	-2.67 (17)	.016*	0.85
Female Emotional Engagement	18.6 (1.8)	19.3 (5.1)	-.782 (9)	.454	0.18
Male Overall Engagement	59.5 (11)	68 (6.6)	-2.8 (17)	.012*	0.94
Female Overall Engagement	65.1 (5.1)	66.7 (10.2)	-.508 (9)	.624	0.198

Discussion

This empirical study aimed to evaluate the impact of utilizing Apple's iPad as a teaching tool on children's engagement within classroom based learning. The results suggest that using the iPad in a classroom increases overall engagement, as well as cognitive and emotional engagement specifically. Campbell (2008) and Buhs, Ladd & Herald (2006) underlined the importance of providing a classroom environment designed to cultivate pupil engagement in order to enhance learning. Our results suggest this can be achieved in part by implementing this technology in schools.

The attributes of iPad that make it attractive to teachers to use in the classroom (e.g. immediacy of the iPad, the fact that the battery lasts all day, the size and portability of the device) were what drove this particular project in this direction rather than towards PC use. Thus lessons were not about technicalities of computing and actively against the idea that you have to be highly technical to use a computer. It is possible that the same functionality may be gained from other tablet-based devices.

Gender Differences

The results underline the potential of such technology in increasing boys' classroom engagement. There has been much concern with declining male achievement in education in recent years (Trent & Slade, 2001). Whilst it cannot be suggested from this study that the decline can be wholly arrested by utilizing iPad technology in the classroom, the results suggest that there are potential benefits that are specific to boys in harnessing the technology effectively. It could be suggested that within this sample, boys' level of classroom engagement has been raised to levels comparable to those seen in girls. This is a result worthy of note. It is important to note that the variation in scores between gender means in this study is typically between 2% and 4%. Therefore, although significant gender differences do exist, the quantifiable difference is slight. The presence of moderate Cronbach's α values for emotional engagement and behavioural engagement are interesting to note, and indicate that further refinement of the scale could ensure greater reliability. In addition, this moderate reliability may explain the lack of significance with regards the behavioural measure.

Traditional approaches focus upon non-biological explanations for the differences seen in educational achievement and engagement between the sexes (Buchmann et al., 2008) while more recent research, in particular neuropsychology, has highlighted underlying neurological differences. Consistent cognitive gender differences are found in verbal, language, and certain spatial skills, with girls demonstrating greater language skills earlier (Feingold, 1993; Halpern, 2000; Hyde & Linn, 1988). This gender discrepancy could lead to lower levels of engagement of boys in the classroom, partially account for the differences in attainment described previously. The use of technology such as outlined in this study may allow some of these specific differences to be partially bypassed in the classroom.

There is evidence to suggest that boys and girls differ in their usage of ICT. These differences may contribute to the observed gender differences above. Waite, Wheeler & Bromfield (2006) found that in a primary classroom, boys preferred using a variety of core aspects of ICT than girls, and that girls used ICT for more social reasons, whilst Underwood et al (2008) found secondary level girls to be less responsive to ICT use than boys. In addition, there are documented differences in exposure to technology in the home environment. The New Zealand Ministry of Health (2003) found that boys aged 5-14 spend on average more time than girls watching TV and playing computer games.

There is a growing body of evidence to suggest, however, that ICT usage does not negatively impact upon girls' success, but rather raises that of boys to the levels previously observed in girls, closing the attainment gap developed in recent decades (Younger et al., 2005). Passey (2004) found that boy's motivation in the classroom was raised by ICT incorporation, but that girls were not disadvantaged, and it may even help boys develop working patterns similar to those displayed in girls. Research reporting pupils' perceptions also seems to concur with the observational data. Hayward et al (2003) found that boys reported finding computers more motivating than traditional teaching, whilst girls were more likely to say they made no difference (rather than decreasing motivation).

Our results would very much concur with the trend in the research. The girls in our study did not decrease in their engagement when using the iPad, but remained steady, whilst boys' engagement improved to meet the level of girls. In addition, the large standard deviation in overall engagement for girls suggests that the engagement levels were more spread in the female sample than the male. This suggests that, for some of the girls in the sample, the iPad did increase engagement, whilst for others, its effects were minimal. There could be other factors within the female sample that distinguish between those who did, and those who did not find using the iPad engaging. It could be hypothesised that factors such as intellectual ability, previous technological experience, or confidence, may distinguish between engagement levels in girls, but not in boys. Further research is needed in this area.

The gender difference may be due to the nature of the technology itself. Volman et al (2005) found that when beginning an ICT-based activity, girls favoured having an explanation given to them, whereas boys would rather explore the activity for themselves. The nature of the iPad format favours the latter, in that a wide range of applications are available, and often, there are no set guidelines to complete a task using the application. The broad range of applications available means that it is nigh on impossible for teachers to be familiar with every application that might be useful in a particular task, and therefore the pupils are often experimenting with applications before the teacher has had time to become expert. In addition, Cooper (2006) has argued that much educational software is based upon game-like attributes of

scoring points, and competition, and that this may appeal to boys more than girls, thus raising their attainment level.

In terms of the applications (apps) used, a wide variety was available to pupils. During the observations, the pupils used the following as they desired: Brushes, Photoshop Express (Photoshop), ColorSplash, Art Rage, Moxier Collage, Photos, Pages, Moodboard, Keynote and Safari. On the children's use of the apps one of the teachers involved in the study commented:

"The clever thing they did, which as far as I am aware would be much more cumbersome with a desktop or laptop, is to flick between so many Apps. For example a girl of 8 years old (X) carried out the following in the geometry lesson:

a) Found an image on Safari. b) Put into ColorSplash to adjust image c) Put onto PS Express to further adjust image d) Put onto Brushes to add colour and detail e) Saved image onto Moxier Collage to add text.

This was not taught. The pupils had experimented with each App but had free choice as to how to complete their design logo. X decided that this was the best way to make hers. She experimented and was not restricted in which Apps she was allowed to use (out of those available on the iPAD within the school). It was easy for her to use and adjust as she wanted. This allowed her to concentrate on the image she wanted and not to have her time taken up by trying to get each program to run"

One other fundamental area which does need to be addressed is the question of whether or not increased engagement will lead to increased learning. Smith et al (2007) reported increased engagement with the use of interactive whiteboards (and boys in particular showed increased behavioural engagement); however there was no evidence of increased attainment. This is clearly an issue which requires longer term study and which would merit investigation.

Questionnaire Development

For the purpose of this study, we developed an observational checklist of engagement. Though other measures of engagement are available (Ellett & Chauvin, 1991; Ysseldyke & Christenson, 1993; Greenwood & Delquadri, 1988), it was felt that it was necessary to develop our own tool. Engagement is a multifaceted construct (Fredricks et al., 2004), and it was necessary for the specific items to be equally applicable to both the usage of iPad, and the traditional class setting, and no such measured existed within the literature.

Limitations

Study Design and Sampling

This study utilized an opportunistic sample of pupils attending a private school in which iPads were being used in the classroom. Due to the size of the school, the sample size is smaller than would be ideal, thereby potentially reducing the scope for drawing firm conclusions. Further research is therefore required with a larger sample size. Further investigation is also warranted into lower socioeconomic cohorts, in order to ascertain whether these differ in engagement from those in privately funded education.

In addition, an objective measure of performance on both tasks would be optimal, as observer bias is possible in observational data gathering. Any underlying bias in the observers' judgements about the role of technology in engaging boys may have unconciously influenced their scoring. It may be interesting to investigate further the gender differences in engagement levels, and to ascertain whether any increase in engagement is translated into academic achievement.

There may be additional explanations for the engagement observed which warrant further investigation. There is a difference in the mean of the ages between the boys and girls of 2 years which may impact the findings. Alternatively, it is possible that the presence of observers in the classroom may affect the children's performance although we have no evidence that this would effect boys more than girls.

Technology Related Issues

The nature of iPad deployment may also impact upon engagement. As the children has been using their iPads in class for 7 months, their engagement in classes where iPads were removed for the study may be impacted by the removal. However, the pupils were still exposed to classes where iPad use was minimum or absent, and therefore were perhaps less inclined to experience negative emotions upon their removal. The teachers involved in the pilot have been using tablet devices since before they were introduced in the school and are competent users of the technology. Clearly not all teachers will have the same background with regards to the use of technology and ongoing staff training and support is likely to be a key feature of successful implementation of the technology. Particular 'apps' may also be more engaging than others and the effects may be subject dependant; this is an area which would be interesting to study further.

Implications and Conclusion

A number of implications emerge from this study which may impact upon educational theory and practice. Educators are continually in search of ways to improve engagement of pupils in the classroom as a means of maximising pupil attainment and enjoyment of school. Our results suggest that the technology afforded by the 'iPad' can contribute to classroom engagement. In addition, it appears that, as the literature suggests, boys may benefit in particular, facilitating the rise of their engagement to levels

observed in girls. Given the growing concern over how well the education system caters for the needs of boys, implementing this sort of technology in schools would appear a valuable endeavour.

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The study was approved by University of Glasgow, School of Education ethics committee. All participants, as well as their parents, provided written consent. There study was unfunded and there are no conflicts of interest.

References

Arrowood, D., & Overall, T. (2004). Using technology to motivate children to write: Changing attitudes in children and preservice teachers. In R. Ferdig et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2004* (pp. 4985–4987).

Assor, A. & Connell, J.P. (1992). The validity of students' self-reports as measures of performance-affecting self-appraisals. In D.H. Schunk & J. Meece (Eds.), *Student Perceptions in the Classroom* (25-46). Hillsdale, NJ: Lawrence Erlbaum.

Atkinson, E. S. (2000). An investigation into the relationship between teacher motivation and pupil motivation. *Educational Psychology,* 20 (1), 45-57.

Barkatsas, A., Kasimatis, K., & Gialamas., V. (2009). Learning secondary mathematics with technology: Exploring the complex interrelationship between students' attitudes, engagement, gender and achievement. *Computers & Education,* 52 562–570.

Beeland, W. D. (2002). Student Engagement, Visual Learning and Technology: Can Interactive Whiteboards Help? Retrieved May 11, 2011, from the Valdosta State University. Web site: http://chiron.valdosta.edu/are/Artmanscrpt/vol1no1/beeland_am.pdf.

Bloom, B. (1976). Human characteristics and school learning. New York: McGraw-Hill.

Bonwell, C. & Eison, J. (1991). Active Learning: Creating Excitement in the Classroom. ASHE-ERIC Higher Education Report, Washington, D.C.

Buchmann, C., DiPrete, T. A., & McDaniel, A. (2008). Gender Inequalities in Education. *Annual Review of Sociology*, 34, 319-337.

Buhs, E. S., Ladd, G. W., & Herald, S. L. (2006). Peer exclusion and victimization: Processes that mediate the relation between peer group rejection and children's classroom engagement and achievement? *Journal of Educational Psychology*, 98 (1), 1-13.

Campbell, D. E. (2008). Voice in the Classroom: How an Open Classroom Climate Fosters Political Engagement Among Adolescents*. Political Behavior*, 30 (4) 437-454.

Case, J. M. (2008). Alienation and engagement: development of an alternative theoretical framework for understanding student learning. Higher Education 55(3): 321-332

Chapman, E. (2003). Alternative approaches to assessing student engagement rates. *Practical Assessment, Research & Evaluation*, 8 (13). Retrieved May 18, 2012 from: http://PAREonline.net/getvn.asp?v=8&n=13

Chung, Y., & Walsh, D. J. (2006). Constructing a joint story-writing space: The dynamics of young children's collaboration at computers. *Early Education and Development, 17*(3), 337–420.

Connell, J. P., Spencer, M. B., & Aber, J. L. (1994). Educational risk and resilience in African-American youth: Context, self, action, and outcomes in school. *Child Development,* 65, 493- 506.

Cooper, J. (2006). The digital divide: the special case of gender. *Journal of Computer Assisted Learning,* 22, 320-334.

Cortis & Newmarch, (2000) *Gender and Education: the Evidence on Pupils in England*. (Department for Education and Skills) Retrieved May 11, 2011, from Department of Education, The National Strategies website: http://nationalstrategies.standards.dcsf.gov.uk/node/83356

Couse, L.J & Chen, D.W (2010) A Tablet Computer for Young Children? Exploring Its Viabilityy for Early Childhood Education. *Journal of Research on Technology in Education* 43(1), 75–98.

Department of Education (2003) Boys *achievement in secondary schools.* Retrieved May 11, 2011, from: https://www.education.gov.uk/publications/standard/publicationDetail/Page1/HMI%201659

Ellett, C.D., & Chauvin, E. (1991). Development, validity, and reliability of a new generation of assessments of effective teaching and learning: Future directions for the study of learning environments. *Journal of Classroom Interaction*, 26(2), 25-36.

Evenstuen, A., Dalen, J. T., and Midtbø, O. H. (2010). The use of ipad as a learning tool. Retrieved May 11, 2011, from:

http://www.uio.no/studier/emner/matnat/ifi/INF4260/h10/student-projects/The Use of iPad as a Learning Tool/Final Report HCI.pdf

Feingold, A. (1993). Cognitive gender differences: A developmental perspective. *Sex Roles, 29* 91-112

Finn, J., & Rock, D. (1997). Academic success among students at risk for school failure. *Journal of Applied Psychology*, 82(2), 221-234.

Forde, C., Kane, J., Condie, R., McPhee, A., & Head, G. (2006*). Strategies to Address Gender Inequalities in Scottish Schools: A Review of the Literature.* Retrieved May 11, 2011 from Scottish Government Website: http://www.scotland.gov.uk/Publications/2006/05/03105823/0

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59-109.

Fredricks, J.A., Blumenfeld, P., Friedel, J., & Paris, A. (2005). School engagement. In Moore, K. A. & Lippman, L. (Eds.) What do children need to flourish?: Conceptualizing and measuring indicators of positive development. New York, NY: Springer Science and Business Media.

Frolik, J., & Zurn, J. B. (2004). Evaluation of Tablet PCs for engineering content development and instruction. *American Society for Engineering Education Annual Conference Exposition*, 102-105.

Greenwood, C.R., & Delquadri, J. (1988). Code for Instructional Structure and Student Academic Response (CISSAR). In M.Hersen and A.S. Bellack (Eds.), Dictionary of Behavioural Assessment (120-122). NY: Pergamon.

Gonida, E. N., Voulala, K., & Kiosseoglou, G. (2009). Students' achievement goal orientations and their behavioral and emotional engagement: Co-examining the role of perceived school goal structures and parent goals during adolescence. *Learning and Individual Differences*, 19 (1), 53-60.

Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in Schools* 30, 79–90.

Halpern DF. 2000. *Sex Differences in Cognitive Ability*. Hillsdale, NJ: Lawrence Erlbaum

Hayward, B. et al. (2003). Young people's use of ICT 2002. ICT in Schools Research and Evaluation Series No.12. Becta/DfES.

Hyde, J., & Linn, M. (1988). Gender differences in verbal ability: a meta-analysis. *Psychological Bulletin, 104*(1), 53-69

Jackson, J.F.L., Moore J. L. & Leon, R.A. (2010). Male Underachievement in Education Across the Globe: A Shift in Paradigm for Gender Disparities Regarding Academic Achievement. *International Encyclopedia of Education*, 838-844.

Jacobsen, M., Clifford, P., & Friesen, S. (2002). Preparing teachers for technology integration: Creating a culture of inquiry in the context of use. *Contemporary Issues in Technology and Teacher Education*, 2(3), 363-388.

Jenkins, P. H. (1995). School delinquency and school commitment. *Sociology of Education* 68, 221–39.

Johnson, W., McGue, M., Iacono, W. G. (2007). How parents influence school grades: Hints from a sample of adoptive and biological families. *Learning and Individual Differences*, 17 (3), 201-219.

Jones, A. Issroff, K. & Scanlon, E. (2007) Affective factors in learning with mobile devices. In M. Sharples (Ed) Big Issues in mobile learning (p. 17-22) LSRI University of Nottingham.

Kearney, S. P., & Perkins, T. (2011). Improving engagement: The use of 'Authentic Self and Peer Assessment for Learning' to enhance the student learning experience. Paper presented at the Academic and Business Research Institute Conference. Las Vegas, Nevada, 6-8 October.

Kearsley, G., & Shneiderman, B. (1998). Engagement Theory: A Framework for Technology-Based Teaching and Learning. *Educational Technology*, 38, (5) 20-23.

Kirsch, I., de Jong, J., Lafontaine, D., McQueen, J., Mendelovits, J., & Monseur, C. (2002). Reading for change: Performance and engagement across countries. Paris: OECD. Retrieved May 11 2011 from: http://www.oecd.org/dataoecd/43/54/33690904.pdf

Kovalik, (2008) Gender Differences and Student Engagement Retrieved May 11 2011 from:http://www.leadered.com/pdf/Student%20Engagement%20and%20Gender%20white%20paper.pdf

Lee, E., A., Wong, K. W., & Fung, C. C. (2010). How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach. *Computers & Education* 55, 1424–1442

Ministry of Health (2003). NZ food and NZ children: key results of the 2002 National Children's Nutrition Survey. Wellington: Ministry of Health.

Majoka, M. I., Dad, M. H., & Mahmood, T. (2010). Student Team Achievement Division (STAD) as an Active Learning Strategy: Empirical Evidence From Mathematics Classroom. *Journal of Education and Sociology*, 16-20.

Masrom, M. & Ismali, Z. (2010) Benefits and Barriers to the use of Mobile learning in education. In Guy, R. Mobile Learning: Pilot Projects and Initiatives. P. 9026) Santa Rosa. California: Informing Science Press.

Passey, D, Rigers, C, Machell J & McHugh G (2004). The motivational effect of ICT on pupils - research report RR523. DfES. Retrieved May 11 2011 from: http://www.dfes.gov.uk/research/data/uploadfiles/RR523new.pdf

Plumm, K. M. (2008). Technology in the classroom: Burning the bridges to the gaps in gender-biased education? *Computers & Education* 50, 1052–1068.

Schmid, R. F., Miodrag, N., & DiFrancesco, N. (2008). A human-computer partnership: The tutor/child/computer triangle promoting the acquisition of early literacy skills. *Journal of Research on Technology in Education, 41*(1), 63–84.

Schunk, D.H., & Zimmerman. B. J. (Eds.) (1994). Self-regulation of learning and performance: issues and educational applications. Hillsdale, N.J: L. Erlbaum Associates.

Scotland's Digital Future: A Strategy for Scotland (2011). Retrieved May 11 2011 from Scottish Government Website: http://www.scotland.gov.uk/Resource/Doc/981/0114237.pdf

Sharples, M. Taylor, J. & Vavoula, G. (2007) A theory of learning for the mobile age. In R. Andrews & C. Haythornthwaite (Eds). The Sage handbook of e-learning research (p. 221-247) London: Sage.

Shneiderman, B. (1994) Education by Engagement and Construction: Can Distance Education be Better than Face-to-Face? Retrieved May 11 2011 from http://www.hitl.washington.edu/scivw/EVE/distance.html.

Shneiderman, B., Alavi, M., Norman, K. & Borkowski, E. (1995). Windows of opportunity in electronic classrooms, Communications of the ACM, 38(11), 19-24.

Shneiderman, B. (1998), Relate-Create-Donate: An educational philosophy for the cyber-generation. *Computers & Education*, 31(1) 25-39.

Skinner, E.A., & Belmont, M.J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology*, 85(4): 571-581.

Smith F., Hardman F. & Higgins S (2007): Gender inequality in the primary classroom: will interactive whiteboards help?, Gender and Education, 19:4, 455-469

Tamin, R.M., Bernard, R.M. Borokhovski, E. Abrami, P.C. & Schmid, R.F. (2011) What Forty Years of Research Says About the Impact of Technology on Learning: A Second-Order Meta-Analysis and Validation Study. Review of Educational Research, 81:1, 4–28

Trent, F., & Slade, M. (2001). Declining rates of achievement and retention: the perceptions of adolescent males Report to the Department of Education, Training and Youth Affairs, Evaluations and Investigations Programme, Higher Education Division, Commonwealth of Australia, Canberra.

Underwood, J., Baguley, T., Banyard, P., Coyne, E., Farrington-Flint, L., & Selwood, I.S. (2008). Impact 2007: Personalising learning with technology. Becta.

Voelkl, K. E. (1995). School warmth, student participation, and achievement. *Journal of Experimental Education* 63(2): 127–38.

Volman, M., van Eck, E., Heemskerk, I., & Kuiper, E., (2005). New technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. *Computers and Education,* 45, 35-55.

Waite, S.J., Wheeler, S. & Bromfield C. (2006). Our flexible friend: the implications of individual differences for information technology teaching. *Computers & Education,* 48, 80-99.

Willis, C. & Miertschin, S. (2004). *Tablet PC's as Instructional Tools or the Pen is Mightier than the Board.* Proceedings of the 5th conference on Information technology education 153-159.

Willms, J. (2003). Student engagement at school: A sense of belonging and participation results from PISA 2000. Paris: OECD. Retrieved May 11 2011 from: http://www.oecd.org/dataoecd/42/35/33689437.pdf

Wishart, J. & Blease, D. (1999). Theories underlying perceived changes in teaching and learning after installing a computer network in a secondary school. *British Journal of Educational Technology, 30*(1), 25-42.

Ysseldyke, J. & Christenson, S. (1993). TIES-II: The Instructional Environment System-II. A system to identify a student's instructional needs. Eric Document No. 367072.

Younger, M. & Warrington M. (2005). Raising Boys' Achievement. (DfES Research Report no. 636). London: Department for Education and Skills.

Technology & Engagement in Class: Observer Checklist

Please use the following checklist to evaluate the engagement of **one child** over a half an hour session by observing behaviour and rating each item using the scale provided

1 = not at all
5 = very much

Child appears enthusiastic about tasks	1 ☐	2 ☐	3 ☐	4 ☐	5
Child appears confident in their learning	1 ☐	2 ☐	3 ☐	4 ☐	5
Child demonstrates interest in the task by asking appropriate question of teacher	1 ☐	2 ☐	3 ☐	4 ☐	5
Child speaks appropriately to teacher	1 ☐	2 ☐	3 ☐	4 ☐	5
Child is keen to try new experiences	1 ☐	2 ☐	3 ☐	4 ☐	5
Child seems interested in tasks given	1 ☐	2 ☐	3 ☐	4 ☐	5
Child speaks appropriately to classmates	1 ☐	2 ☐	3 ☐	4 ☐	5
Child looses their temper in class	1 ☐	2 ☐	3 ☐	4 ☐	5
Child makes appropriate eye contact with others when talking to them	1 ☐	2 ☐	3 ☐	4 ☐	5
Child seems to comprehend visual instruction	1 ☐	2 ☐	3 ☐	4 ☐	5
Child looses interest during tasks	1 ☐	2 ☐	3 ☐	4 ☐	5
Child seems to comprehend verbal instruction	1 ☐	2 ☐	3 ☐	4 ☐	5
Child interacts appropriately with classmates	1 ☐	2 ☐	3 ☐	4 ☐	5
Child appears engaged in task	1 ☐	2 ☐	3 ☐	4 ☐	5
During group time, child sits and listens most of the time	1 ☐	2 ☐	3 ☐	4 ☐	5
Child appears to concentrate well on tasks	1 ☐	2 ☐	3 ☐	4 ☐	5
Child finishes work tasks efficiently and in the time allocated by the teacher	1 ☐	2 ☐	3 ☐	4 ☐	5