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What's the difference? Learning collaboratively using iPads in conventional classrooms

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**Title:**

**What's the difference?  
Learning collaboratively using iPads in conventional  
classrooms.**

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**Abstract**

Since its release in 2010, Apple's iPad has attracted much attention as an affordable and flexible learning tool for all levels of education. A number of trials have been undertaken exploring the device's efficacy for specific purposes, such as improving delivery of course content and learning resources at tertiary level, and the performance of apps for meeting specialised learning needs. However, with increased mainstreaming of these devices through iPad-supported modern learning environment (MLE) and Bring Your Own Device (BYOD) programmes, data are becoming available that provides insight into how these devices function as part of regular classroom environments. This article reports an analysis of data collected over almost 3 years from nearly 100 New Zealand primary (elementary) students of different ages, who used iPads daily for most curriculum tasks. Specifically, it uses different data sources to explore how observed and recorded device design and app attributes, affected the students' ability to work collaboratively.

Results suggest fundamental differences exist between iPads and other digital devices that helped these students collaborate, and that when combined with cloud-based apps and services such as Google Docs, extended this collaboration to much wider audiences well beyond the school gate. It concludes that beyond the hype and rhetoric, exciting potential exists for this tool to support a 'blurring in the line' between learning in formal school and informal environments.

**Keywords:** iPad, collaboration, Google Docs, learner, BYOD

**Highlights**

Reports on a three year study of iPad use in regular classrooms

Identifies design features of iPads that help learners collaborate

Discusses how iPads and cloud apps can extend learning beyond the classroom

Discusses how iPads can facilitate feedback from multiple sources to support learning

## 1. Introduction

This article reports an analysis of data collected between 2012-14 from nearly 100 New Zealand primary (elementary) school students of different ages, who used iPads in a range of collaborative learning scenarios. It combines analysis of display recordings from all students with survey and focus group data collected from groups of 7-10 year olds, to learn more about how features of iPads and apps affected their ability to work collaboratively. The study was prompted following analysis of display-recorded data for other purposes (see below), which revealed consistent patterns of design-related device and app use across the groups that appeared to support their collaborative endeavours. However, further investigation was needed to determine if initial observations were correct, and if so, how relevant students viewed the device and app features for supporting their collaboration. Such an analysis is timely given the rapid adoption of these devices in classrooms as individual and collaborative learning tools, and the level of hype and rhetoric surrounding their so-called transformative potential. The study examines if any differences exist between the iPad and other digital devices that may make it a 'stand out performer' for supporting learner collaboration.

## 2. Learner collaboration and handheld technologies

Studies spanning many years have pointed to the potential of digital technologies for supporting collaboration between learners and teachers, both in distance education and conventional classroom contexts (eg., Brandon & Hollingshead, 1999; Cronje, 1997; Haythornthwaite, 1999; Hooper, 1992; Kreijns, Kirschner & Jochems, 2002; Neale, Carroll & Rosson, 2004; Roschelle & Pea, 2002; Stanton, Neale & Bayon, 2002). More recently, research attention has turned towards mobile and touch screen technologies as offering new possibilities for supporting school learner collaboration, due to their "mobility, flexibility and instant access... which allows students to engage in highly collaborative activities anywhere, at any time" (Zurita & Nussbaum, 2004, p.293). The first of these studies used handheld devices such as wireless-enabled PDAs (personal digital assistants), generally in planned investigations into learner collaboration in subjects such as mathematics and language. In their Chilean research, Zurita and Nussbaum (2004) structured two interventions supported by purpose-built PDA software. The trial involved a total of 48 six and seven year old students working together to solve puzzle-like challenges, one focusing on word building from syllables in Spanish, and the other on collaborating as a team to numerically match sets of objects. Their analysis drew on the early work of Hollan and Stornetta (1992), Gutwin, Roseman and Greenberg (1996) and Kreijns et al. (2002) in evaluating the extent to which the devices supported learner collaboration in areas research identified as challenging. These were:

1. Coordination (device helps coordinate task activities)
2. Communication (device facilitates communication between team members)
3. Material organisation (device facilitates access to and organisation of task resources)

4. Negotiation (device supports negotiation between team members)
5. Interactivity (device facilitates input into decision making by all team members)
6. Mobility (device allows individual task input and movement with device to other team members at different locations).

Their results indicated using handhelds running appropriately designed software can help students collaborate more effectively on tasks by structuring access to materials, providing a device-imposed system for interaction, negotiation, coordination and communication, and providing flexibility and portability that allowed students to access support anywhere, at any time. They specifically commented on the importance of having access to robust wireless networking that “open(ed) a new world of (collaborative) possibilities” (p.312), while at the same time alluding to the importance of task design, and how this is reflected in the content and interface of the software used.

Zurita and Nussbaum’s findings echo those of an earlier study by Danesh, Inkpen Lau, Shu and Booth (2001) who developed a Palm 3 (PDA) application called *Geney*, and trialled it with small groups of 10-13 year old students. *Geney* was a game designed to help students understand basic genetic concepts such as dominant and regressive, through problem solving activities requiring intra and inter-pair collaboration. Similar to Zurita and Nussbaum’s study, Danesh et al. concluded using handhelds can support student collaboration if the learning task, as reflected through appropriate software design, provided sufficient reason, structure and engagement/motivation to do so. However, their study highlighted device limitations such as the unreliability of Bluetooth-based networking, small screen size, and the limited operating memory and data storage capacity of PDAs. These factors restricted the extent to which more than one student at a time could meaningfully contribute to the task, and also influenced the task itself by placing significant technical design constraints on the software.

Recent developments in mobile technology have spawned a new array of digital, touch screen learning tools, such as Apple’s iPad and Samsung’s Galaxy range. The advent of these relatively affordable, portable and networkable devices with vastly superior specifications to their PDA predecessors and wide array of app choices, has meant many schools now see them as a viable option for equipping their students with a learning resource compatible with the demands of so-called ‘21<sup>st</sup> Century Learning’. Indeed, an increasing number of schools are mandating their inclusion through Bring Your Own Device (BYOD) or mobile-supported programmes, often requiring parents to provide digital tablets in much the same way as exercise and text books are included in stationery lists (Ihaka, 2013). This has led to many more devices being available in classrooms, and their ‘mainstreaming’ as a regular learning resource. The advancement has also offered potential to move away from the research methodologies of the earlier ‘one-off’ trials, towards exploring if and how this new generation of device with its greater ubiquity and enhanced capability, is able to support learner collaboration *integral* to everyday classroom activity. While a few studies have touched on this in relation to device affordances, methodologically these have

still been based on formal trials linked to one-off tasks or specific apps, or learners with particular needs, rather than being completely embedded in routine classroom environments and work (eg., Brand & Kinash, 2010; Culén & Gasparini, 2011; Desai, Chow, Mumford, Hotze & Chau, 2014; Garcia, 2011; Kucirkova, Messer, Sheehy & Panadero, 2014; Lin & Nzai, 2014; Mozaffar, 2012).

One of the few available studies that has attempted to address this research gap was undertaken by Fisher, Lucas and Galstyan (2013). Their research aimed to learn more about “how students interact with one another while using technological devices (iPads) in traditional, face-to-face learning environments” (p.167). It analysed how university students provided with a set of iPads for a semester-long Business Calculus course, used them in a range of group activities designed to develop core course concepts. Their use was compared with other students using laptops for the same tasks. Observational, focus group and survey data were coded under categories relating to physical location of use (public vs private), type of use in space (public vs personal), activity, extent of verbal interaction, and relative dominance of group members. Their results revealed significantly higher levels of device-supported collaboration in public workspaces for the iPad groups, and greater use of iPads for sharing and collaborating *during* work activity, rather than only at its conclusion. Students attributed this to design affordances such as the iPad’s ability to be passed around, the lack of an obstructive, barrier-forming screen, and a display supporting multiple, and if desired, simultaneous interactions. According to Fisher et al., these affordances offered significant advantages over laptops, by allowing students to more easily transition between private and public spaces and uses, according to task demands. While Fisher et al.’s study signals particular design features of iPads supporting learner collaboration, it was still a relatively limited trial located within a single subject discipline in a university. The study detailed in this article is profoundly different, and significantly extends earlier research. It is based on data collected over a period of almost 3 years in three different primary (elementary) school classrooms, where class and group sets of iPads were present ‘fulltime’, and used for the complete array of curriculum learning activities.

### 3. Research questions

Data collection was informed by these questions:

1. What design and technical features of iPads and apps *appear* to support work collaboration in three primary classrooms?
2. How do students perceive these features as supporting, or not, work collaboration?

### 4. Background and research context

The impetus for this study came from data gathered during research work carried out between 2012-2014 in a medium sized primary school located approximately 25km from New Zealand’s fourth largest city. The school was an

early adopter of iPads, initially employing a small set of university-supplied devices in a study using phonic skill-building apps with 5 year olds, and more recently expanding their use through BYOD and iPad-supported modern learning environment (MLE) programmes in middle and senior classrooms (years 3-6). From 2012-2014 data were collected from four groups of students at three class levels. These students used iPads in pairs or small groups for different curriculum-linked purposes – specifically within their language, literacy, mathematics and topic (theme-based) studies. The class levels and student numbers were new entrant (NE) and year 1 (2012 & 2013 – 41 students), year 3 and 4 (2014 – 26 students) and year 5 and 6 (2014 - 28 students). Data were gathered using a unique display recorder app embedded into a set of ten university-supplied iPads the students used. As the devices needed to be 'jailbroken' to operate the recording app, it was not possible to install this app on student-owned devices in the senior BYOD classrooms. Therefore, the set was rotated around the different rooms for research purposes, over the course of the 3 years. The recording app captured as extractable video all display activity, audio, and finger placements (touches), as students were working. The app was activated and deactivated by the researcher via a customised sequence of taps on the display, after which no visible indication of recording was available to the students. However, full consent processes had been followed, and students had been informed of its use for research purposes prior to, and periodically during the study. Specific findings from the analysis of the over 100 hours of display data captured for these earlier studies have been published extensively elsewhere (Author, 2013a; 2013b; 2014; Author & Khoo, 2014).

It should be noted at this point that while data were collected using iPads, similar methods could be applied, and similar results possibly gained, from using other tablet devices based on different operating systems, such as Android or Windows. Indeed, apps exist in both environments that easily allow for display recording without the additional complexity of device jailbreaking (eg., SCR screen recorder; REC capture; Apowersoft capture). iPads were used in this case as they were the 'device of choice' across the school, being specified for the BYOD classrooms and used in the junior school since 2011. Teachers and students were thoroughly familiar with their operation, and reliable supporting infrastructure was well established in the school.

## **5. Data method, collection and analysis**

During collection and analysis of data for the earlier studies, patterns began to emerge across the groups relating to how students used the iPads for working together, and how different attributes and features of the device and certain apps appeared to support these endeavours. These patterns were identified in three ways:

1. Researcher observation, notes from informal conversations with students and teachers, and digital still and video images recorded while students were working;
2. Oral exchanges between students as recorded by the display capture app (within a group, between groups);



3. Display capture video data and associated audio (eg., evidence of screen rotation, multiple touch points, content editing, apps used and explanations/discussions).

The emergent patterns were grouped into two main classifications – the technical and design attributes of iPads, and how students in the years 3-6 classrooms used apps, specifically Google Docs, to work collaboratively. These classifications were further defined into subcategories that were used to generate the data instruments, namely the survey (Appendix A), and from that, the themes and questions for three focus groups (one at year 3 & 4 level and two at year 5 & 6 level, Appendix B). The technical/design subcategories were: screen rotation, device weight and size, display viewing angle, multi user-accessible interface, device portability/mobility, device enabling work in different spaces, accessing different media forms (present & playback), device form factor supporting engagement by multiple students, and audio quality. The app-related classification was defined by two subcategories: students using Google Docs on different iPads to work together *in class*, and students working *somewhere else* (eg., at home) using Google Docs for the same task (usually completing homework or working together on topics).

### 5.1 The survey

A twenty item slider scale/Likert/short response online survey (Appendix A) was developed and administered using SurveyGizmo. Items were generated aligned with the technical and app-related classifications detailed above, in addition to more general items exploring students' views of using iPads for their work. Using 0-10 slider scales, students were asked to rate the iPad's technical and design attributes according to how important they considered each was for supporting work collaboration (questions 6-14). They used a 1-5 Likert scale for the app-related classification (questions 15, 16 and 19), while the short response, collaboration-related items linked to questions 5 and 19, identified themes explored further during the focus groups (*ie., how much do you think being able to use different apps helps you to show and share what you have learnt – how/why?*) and (*do you think using Google Docs on your iPads to work together at the same time helps you make a better job of your work – how/why?*).

Due to their age and for some their relatively limited reading capability, the survey was completed as a class activity with the year 3 and 4s. While each student completed a separate survey, the questions were read aloud and explained by the researcher and the teacher one at a time, to ensure all understood what the question asked and how they were to respond to it. Almost all of the year 3 and 4s were students engaged in the earlier 2012 study as NEs and year ones. As no display recorder data had been collected in the NE/year 1 class during 2014, there was little point in administering the survey at that level. The year 5 and 6 students were able to complete the survey independently. Most completed this in class, while three opted to finish unanswered questions at home. In total, 46 survey responses were gathered from across the middle/senior classes, representing 96% of students present on the day.



## 5.2 The focus groups

Survey responses were analysed and data linked to the two classifications (technical/design and app-related) were explored in depth during three focus group discussions. Each focus group comprised 7-10 randomly selected students – one group was from the year 3 and 4 class (FG 1), and the other two from the year 5 and 6 class (FG 2 & 3). Focus group discussions were of approximately 30 minutes duration, and were initiated using general questions associated with students' short response comments or data from the survey (Appendix B). Additional questions and prompts were used where further elaboration or clarification was required. Dialogue from all groups was digitally recorded and transcribed.

## 5.3 Data analysis

Slider scale and Likert data were exported from SurveyGizmo as .csv files and imported into an Excel spreadsheet. Line charts were generated for responses to sliding scale questions 6-14 (technical/design attributes – Table 1) and bar charts for responses to Likert scale questions 15, 16 and 19 (Table 2). Table 1 displays the number of students allocating ratings at each level on the 0-10 scale, the average rating given, and standard deviation. Table 2 summarises the percentage of students responding at each Likert scale level (1-5), the average rating given, and standard deviation.

Short response data linked to questions 5 and 19 were printed out and coded axially using traditional, manual colour coding. From this, six draft categories were identified for question 5, and 5 for question 19 (see Table 3). At this stage the data and categories were discussed with a colleague who offered input that assisted category refinement, before coding was carried out independently by the researcher and his colleague. A kappa inter-rater agreement calculation was performed on data both raters identified (139 items). This yielded a 'Good' level of agreement<sup>1</sup> between raters ( $\kappa = .684$ ;  $SE = .062$ ;  $CI = 0.563-0.805$ ). Percentages of responses coded under each category were calculated, and these are presented along with corresponding data samples in Table 3.

The transcripts of focus group discussions were reviewed for data that provided further insights or detail expanding on the text responses given in the survey, and aligned with the code categories described previously. Specifically, the review sought more information on why and how students considered the technical/design and app-related attributes of iPads assisted them (or not) to work together, and any issues they may have experienced in achieving this. Verbatim responses from members of the focus groups have been collated in Table 4 alongside the two general classifications, contextual information, and starter questions.

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<sup>1</sup> Landis & Koch, (1977).

## 6. Findings

The tables provide data summaries from the survey, short response questions and focus group discussions, responding to the two classifications identified from the earlier studies linked to facilitating student collaboration (device technical/design and app-related). Table 1 summarises the slider scale data recording students' views of the importance of device technical and design features. It comprises the feature surveyed, a thumbnail image illustrative of the feature taken while students worked, a line chart mapping the number of responses at each rating, and the average and standard deviation. Table 2 combines the survey question, explanation of its related scenario, sample responses recorded in the focus groups or survey text, and a charted summary of Likert data. Table 3 summarises short response data from collaboration-focused questions 5 and 19. It includes the designated code categories, the percentage of responses coded under each category, and attributed (by responder ID) sample data aligned with each category. Focus group data under each classification are collated in Table 4. It contains a summary of the contextual information communicated to the students, the initial open questions asked, and verbatim responses copied from the transcripts. Responses are attributed at group rather than individual level, as the names of students comprising each group were not recorded.

**Insert Table 1 about here:** *Device technical and physical attributes or features supporting collaboration*

**Insert Table 2 about here:** *Apps supporting work collaboration (Google Docs)*

**Insert Table 3 about here:** *Coding from survey short response*

**Insert Table 4 about here:** *Sample data from focus groups*

## 7. Discussion

The following concentrates on findings relevant to responding to the research questions, and therefore does not include discussion of all data contained in the survey. Other survey data relating to students' views of different apps and features, such as that contained in many responses linked to question 5, may be used in subsequent articles.

### 7.1 App-related factors and student collaboration

#### 7.1.1 Google Docs

Short response and focus group data indicated these students considered some apps valuable for facilitating feedback, that they could then use to improve their work. While Google Docs was the 'app of choice' for school work, others mentioned Edmodo, Skype and iMessage as means of sharing their work with others and receiving feedback, frequently from parents or relatives living at a distance (Table 3, b; Table 4, f.). While most use of Google Docs was in class (90%

ranking at 'sometimes' or more), Likert data indicated a substantial number of students also used it at home or elsewhere for school purposes, mainly for working on homework or extending class topic work, or for catching up on work they had not completed at school (Q. 15: 48% ranking use at home at 'sometimes' or more). A few students also used Google Docs to assist with personal organisation (Table 3, jj) and for storing their work so they didn't lose it (Table 3, ll; Table 4, g).

Feedback through Google Docs occurred either synchronously or asynchronously, the former appearing to be of greater formative value while students were working. Synchronicity allowed them to edit or add content or correct each other's mistakes, while work was being drafted (Table 4, j). Working synchronously with others using more than one device was also associated with a perception of producing 'better work, faster' as ideas could be combined at any time, another person was available 'on tap' to help, prompt, or provide advice if needed, and two or more people could work on the same output concurrently (Table 3, ff; Table 4, b, d, e). When working at a distance in this way, some students utilised other synchronous systems such as Skype alongside Google Docs to provide audio and visual interaction, which they considered enhanced their experience (Table 4, b).

Some comments tentatively suggested using apps like Google Docs 'blurred the line' between school and home. Data samples d and e in Table 4 illustrate this, by implying it supported a level of *seamlessness* between work they do at school and home, enabling them to pick up what they are doing in either environment and complete it more efficiently. The *convenience* of the interaction facilitated by Google Docs also appears important. As illustrated by samples a and d (Table 4), students appreciated being able to collaborate on their work at times that suited them, rather than needing to wait until they were back at school when "you've probably forgotten all about it" (Table 4, d). Such benefits also extended to students who were behind with their work, or may have needed additional support from others to understand concepts introduced in class (Table 4, c). Interestingly, one comment suggested using Google Docs to get and give help out of school was rewarding for both parties, with the 'teacher' benefiting from explaining and clarifying concepts for someone else, without the pressure of time (Table 3, gg).

Google Docs also supported the communication and sharing of work with parents and others (relatives etc.) who may or may not be residing with the student. While it is not clear whether this was done synchronously or asynchronously, the importance of the feedback these interactions provided was apparent, both in terms of affirmation or support (Table 3, aa; Table 4, f), and also formatively for work improvement (Table 3, hh). A common theme evident across most data was how students used apps like Google Docs to expand the audience for their work, enabling them to access encouragement, support, advice and guidance from a wide array of people with an interest in their progress, virtually at any time. Interestingly, one teacher (Miss M) identified this as both a strength and a weakness of the system, commenting that she needed to place parameters around expectations of feedback from her, after school hours (ie., not

after 5pm). Failing to do this initially led to students submitting work for feedback “at all hours, and I never got a break” (Miss M, informal communication, March 20, 2014).

### 7.1.2 Other apps

AirServer and Apple TV were used extensively by all classes to share work and facilitate feedback on work from teachers and other students. AirServer is a wifi-based app that can broadcast the displays of single or multiple iPads via Apple TV, to large HD televisions installed in all classrooms (Figure 1). At various points during and at the conclusion of most activities, students shared progress and outcomes using this system, and received feedback that some considered valuable for their learning (eg., Table 3, d; Table 4, i). Although, like Google Docs, occasional technical issues caused some frustration, students generally felt the system worked seamlessly and reliably, enabling them to share work and benefit from others’ input (Table 4, i). It should be noted that in all classes much teaching work had been carried out to ensure students knew what useful feedback was, and how to communicate it clearly and objectively. This was essential for ensuring worthwhile feedback was appropriately communicated using this system.

**Insert Figure 1 about here:** *Sharing work and receiving feedback via Apple TV*

### 7.2 Device technical and design-related factors and student collaboration

The slider scale summaries in Table 1 suggest students greatly valued the iPad’s portability that allowed them to work together in different spaces and places (Q. 11, Av.=8.6). Focus group data supports this (eg., Table 4, k, l, q), and strongly links this attribute with working collaboratively through being able to easily carry the device to different parts of classroom or another environment, to get from, or give assistance to, other students (Table 4, l). Interestingly, students did not see the iPad’s compact size and light weight as being an overly critical factor when collaborating within a group (Q.7, Av.=6.6), but more so when moving around the classroom to interact with others (Q.10, Av.=7.8). Focus group data suggested robustness (Table 4, p) and design/form factor (Table 4, l) encouraged them to move with the device and easily interact with others. One student suggested fundamental design differences existed between iPads and laptops that aided their robustness and portability, and helped collaboration between groups. The absence of a hinged screen was viewed advantageously, the student’s comment implying that carrying a laptop with the screen open was riskier, and that it got in the way when needing to work together (Table 4, l). They also associated the iPad’s portability with improved work, and being able to “fix it (work), you know, on the spot” (Table 4, l).

Display visibility to a group through being able to angle the iPad on its case stand for different purposes such as viewing YouTube clips, rated very positively (Q.12, Av.=8.6). However, this attribute did not appear to transfer to group members being able to simultaneously interact with the device – that is, actually add content or edit at the same time by manipulating on-screen elements (Q.9,

Av.=5.7). This finding was explored in the focus groups, where comments were made suggesting more than one person at a time interacting with the display was problematic (Table 4, m, s). One student commented that too many inputs was “a bit confusing (if everyone wants to do things on it all at once)... you have to be organised” (Table 4, m), while another stated the screen size was too small – “it’s too crowded otherwise” (Table 4, s). Despite these issues, students organised systems whereby turns were taken to input content while other(s) observed, offered suggestions and advice, or checked the accuracy of inputs. Several examples of clusters of students surrounding a device on all sides were noted (eg., Figure 2), with display capture audio indicating restricted physical device access had minimal effect on levels of collaboration. Such practices appeared to be supported somewhat by the iPad’s wide viewing angle (Q.8, Av.=6.7), enabling generally good visibility from the side and above (Table 4, s). An exception to this was voiced by one student who noted limitations when working outside, as direct sunlight “makes it hard to see” (Table 4, k).

**Insert Figure 2 about here:** *Display visibility supported group collaboration*

While technical attributes such as screen rotation and sound quality generally rated quite well for supporting collaboration (Q.6, Av.=6.7; Q.14, Av.=7.9 respectively), some limitations were noted in the focus groups – in particular, issues with the screen rotating of its own accord when not wanted (Table 4, o) and problems with sounds annoying other students or not being audible due to levels of ambient noise (Table 4, r). While students implemented a solution for screen rotation (locking), the audio issue was more troublesome. Audio splitter boxes had been purchased that allowed up to four headphones to be connected to the one device, and while this adequately catered for audio playback (such as from YouTube), it meant students needed to take their headphones off each time they wanted to discuss anything, or if they were generating or editing audio themselves. In these cases groups often moved to quieter locations, which at times were challenging to find. While the effect of this on their ability to collaborate was not explored in depth, it would not be unreasonable to assume it had some negative impact, or at least caused a degree of frustration.

## 8. Conclusion

When considering the outcomes of this study, it is important to keep in mind a number of contextual factors. First, having access to iPads such as described here will not guarantee collaboration. iPad use in these classes was embedded in curricula purposely designed to foster learner collaboration and higher order and critical thinking skills. Most tasks data were recorded during were inquiry, scenario, problem or project-based, with a stated expectation that students work in pairs or small teams when developing outcomes. While this did not necessarily mean students always shared a single device face-to-face, for often they used their own devices networked via Google Docs (etc.) to collaborate remotely, task design was of a nature that dictated outcomes were to be collaboratively developed, with negotiated success criteria (assessment rubrics) reflecting this. Second, much work had been carried out by teachers developing skill sets supporting student collaboration. These included specific face-to-face



and technology-mediated tasks requiring debate and negotiation, team research and outcome presentation, asking and answering good questions, assigning team roles and so on. In short, a culture and curriculum encouraging and expecting collaboration had been deliberately built in each classroom. This approach permeated all classes in the school, which had developed its own curriculum model around a values-based framework they named ‘The 6 Cs’ (see Figure 3). Central to this model was the development of strong communication, collaboration and teamwork skills.

Third, the school had built the technical infrastructure that allowed its students to collaborate using their devices. A robust wifi network covering the entire school including the playground enabled free movement between learning spaces, and network technical and security systems were flexible enough to allow students and others access to shared learning resources from home and beyond. This made working together technically easy and seamless, and undoubtedly supported wider involvement in student activities, such as from family or relatives living at a distance.

Collaboration has been identified as an essential skill for future workplaces, and the role of formal education systems in developing both an appreciation of the need for collaboration, and the skillset to support it, has been well documented (eg., Kaplan, 2014; Trilling & Fadel, 2009). Studies such as those synthesised in the earlier review point to a valuable role for technology in this process. Lately however something of a ‘backlash’ has developed, with some commentators claiming that “technology isolates children from each other, and may be hampering their communication and collaboration skills... we risk educating an entire generation of students who don’t know how to work together or communicate effectively...” (Walmsley, 2014, p.80). Such comments appear based on a perception of technology isolating students from each other, largely removing the need for face-to-face communication and collaboration. While these comments may appear extreme, the advent of iPads in classrooms as one-to-one devices, could *potentially* lessen the need for collaborative interaction between students. Indeed the technical setup of iPads as single user profile devices does not encourage collaborative use, as profiles customise settings and access to features appropriate only to the owner.

However, the results of this study suggest a somewhat different perspective. Even looking beyond its physical design affordances, when embedded in thinking classrooms as an everyday learning tool, results indicate iPads may be a powerful resource for supporting collaborative learning. Perhaps above all else, they easily enable students to get *feedback* that can be used to improve their work. This can come from being able to easily share work face-to-face within a group or between different groups within a classroom, with a whole class via large screen displays, across different classes in a school, or even at home with each other, family members, relatives and others, anywhere, at any time. The iPad’s design, robustness, reliability and ease of networking appears to support this multidimensional collaboration. Although such evidence exists, further studies are needed to determine whether this contributes in any way to better (or different) learning. Anecdotal comments from the teachers involved suggest

this *should* be the case, but limitations to the data methods used here and the problematic nature of defining any learning or achievement affect relative to a specific technology-supported intervention, do not allow any definitive conclusions about this to be reached. Regardless, and while not advocating an 'all or nothing' approach, when used intelligently and purposefully, iPads appear to be a useful resource for developing and exercising highly-valued collaborative skills in students.



## References


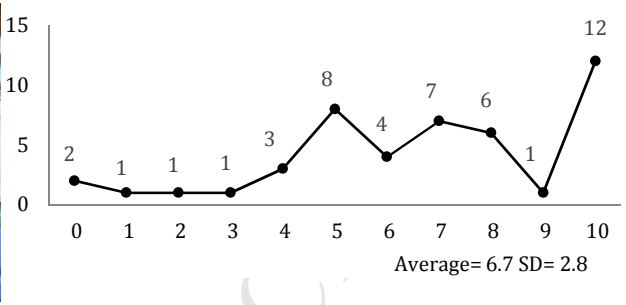

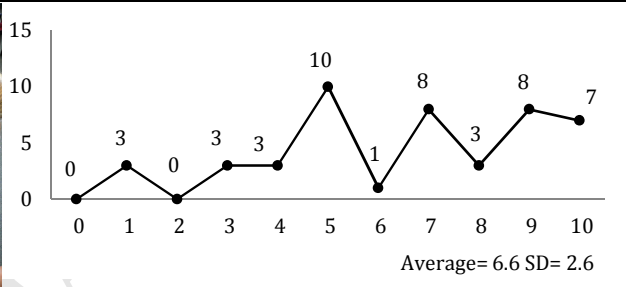

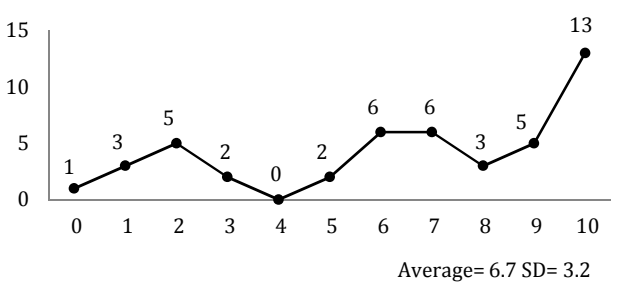

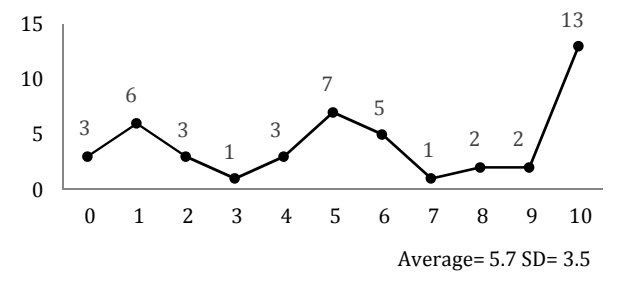

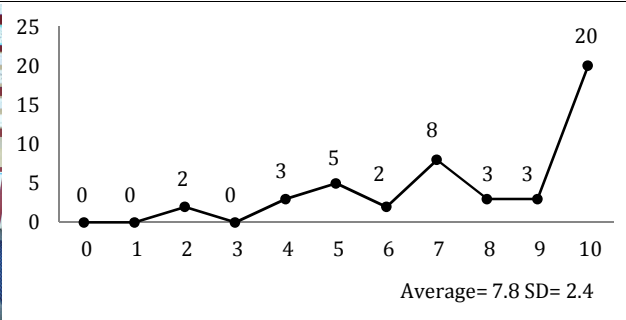
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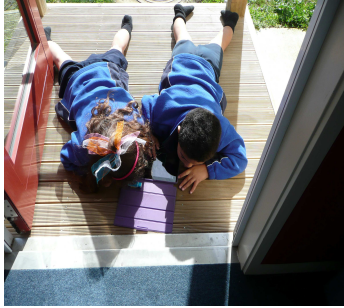
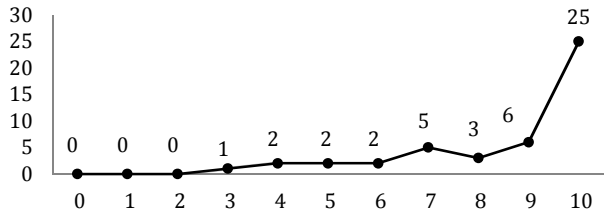

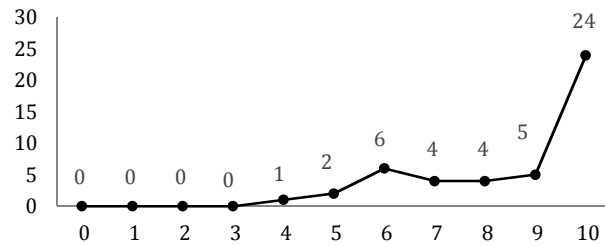

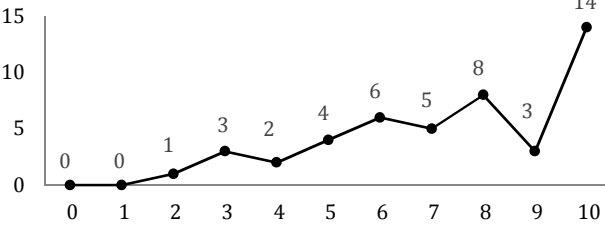

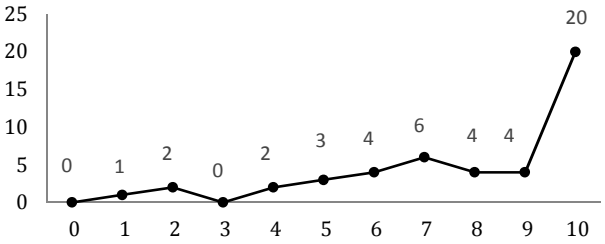
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**Table 1.**

Device technical and physical attributes or features supporting collaboration

Survey question or focus	Attribute or technical feature	Illustrative thumbnail captured during class activities.	Number of responses (y) at each rating (x)
6. The screen rotates so others can see it without needing to move	Screen rotation		 <p>Average= 6.7 SD= 2.8</p>
7. We can pass the iPad around members of our group because it is small and light	Compact size and weight		 <p>Average= 6.6 SD= 2.6</p>
8. The screen can be seen clearly by others looking from the side	Wide viewing angle		 <p>Average= 6.7 SD= 3.2</p>
9. More than one person at a time can touch the screen and do things on it	Multi-user accessible interface		 <p>Average= 5.7 SD= 3.5</p>
10. iPads are small and light and they can be carried around the classroom so we can talk or share with others what we are doing	Portability and mobility		 <p>Average= 7.8 SD= 2.4</p>



Survey question or focus	Attribute or technical feature	Illustrative thumbnail captured during class activities.	Number of responses (y) at each rating (x)
11. We can use iPads anywhere. We don't have to be sitting at desks	Supports working in different places and spaces (public or private) and with different people		 <p>Average= 8.6 SD= 2</p>
12. We can lie the iPad flat or stand it up if we need to, to do different things together	Flexibility in displaying different media (present with & playback)		 <p>Average= 8.6 SD= 1.8</p>
13. We can gather around the iPad and see and discuss what we are doing	Supports group work as others can easily see, engage with and edit work, if desired.		 <p>Average= 7.4 SD= 2.3</p>
14. The iPad has good sound so we can all hear easily	Audio content can be heard by all when working in a group		 <p>Average= 7.9 SD= 2.5</p>

**Table 2.**

Apps supporting work collaboration (Google Docs)

Survey question or focus	Scenario	Typical uses (from focus group)	Likert response summary (percentage of responses at each rating)
15. How often have you used Google Docs <b>in class</b> so you can do your work with others using more than one iPad at a time?	Collaborating <b>locally</b> using Google Docs and 2 or more devices (at school, in class).	Working on stories or reports, preparing visuals (slides), editing/providing feedback, drafting camp supplies list.	<p>Average= 4 SD=1</p>
16. How often have you used Google Docs <b>at home</b> so you can do your work with others using more than one iPad at the same time?	Collaborating <b>at a distance</b> using Google Docs and 2 or more devices for school work (at home, remote locations).	Completing homework, working with others on projects and tasks, preparing for and researching upcoming topics, working on topic extension material, preparing blogs.	<p>Average= 2.6 SD= 1.4</p>
<b>Short responses coded summary (%)</b>			<b>Likert response summary (percentage of responses at each rating)</b>
19. Do you think using Google Docs on your iPads to work together at the same time helps you make a better job of your work? (Why/why not?)	<b>Improves work speed, efficiency, accuracy.</b> <b>Learn to collaborate,</b> help others, involve parents, share work with others who don't live with them (eg., grandparents). <b>Technical advantages</b> (storing work, useful editing tools, easy to type). <b>Use it to do homework.</b> <b>General non-specific</b> (eg., it's easier, helps me, fun).	18 41 6 6 28	<p>Average= 4 SD= 0.9</p>

**Table 3.**

Coding from survey short response

Question	Code category	% responses coded	Data samples by survey response ID
5. How much do you think being able to use different apps helps you to show and share what you've learnt? Reasons given.	Different apps can be selected according to different needs and purposes.	37	<p><i>a. Some apps are good for some things but not others. We can choose which ones we use, depending on what we want to do... (ID 031)</i></p> <p><i>b. You can share what you do on Edmodo or iMessage or Docs... I can show my gran... she lives in Taumaranui... she's always interested in what I do... (ID 053)</i></p> <p><i>c. It's great to use different apps... Pages for writing, Popplet for planning, Keynote for slideshows and producing things. It's like having lots of different books, but each one is better at certain things... (ID 067)</i></p> <p><i>d. You can put your work up on Apple TV and get feedback from everyone. That helps me learn, for sure... (ID 081)</i></p> <p><i>e. I don't have to run around telling everyone my news, I can just use message or other social networks... and apps have unlimited pages... you can put different stuff in them too... (ID 057).</i></p>
	Learning about apps (technically-oriented, how they work).	9	<p><i>f. I love exploring new apps that I have not used. It's good to find out how they work... (ID 052)</i></p> <p><i>g. I've learnt to animate in Keynote... you can make stuff appear and go away again (ID 084)</i></p> <p><i>h. You learn about how new apps work (ID 039)</i></p>
	Apps help improve work appearance or aesthetics.	9	<p><i>i. Your work is always neat. You can make faces on it (ID 057)</i></p> <p><i>j. Because it looks really cool (work) (ID 030)</i></p>
	Apps help make work more accurate.	12	<p><i>k. It helps my spelling. The checker thing comes up with choices, tho' I sometimes pick the wrong one... (ID 050)</i></p> <p><i>l. You can't rub out pen but you can on the iPad. It helps me 'cos I can fix mistakes I make... (ID 055)</i></p> <p><i>m. It tells you if you have spelt incorrectly (ID 057)</i></p>
	Apps extend personal thinking.	6	<p><i>n. They help me be creative (ID 039)</i></p> <p><i>o. They challenge me sometimes... and I like to push myself (ID 030)</i></p>
	General, non-specific (fun, easier, help).	27	<p><i>p. Work's easier on the iPad (ID 079)</i></p> <p><i>q. It is very faster (ID 083)</i></p> <p><i>r. Well, it's fun (ID 088)</i></p> <p><i>s. I just find it better (ID 023)</i></p> <p><i>t. Because apps are easy to use (ID 029)</i></p> <p><i>u. Apps are good to use in reading time (ID 033)</i></p> <p><i>v. It helps me with my learning in class a lot (ID 018)</i></p>
			<p><i>w. If you've got a job to do, you get it done more faster... (ID 081)</i></p> <p><i>x. 'Cos if you make a mistake you can fix it easily... (ID 079)</i></p> <p><i>y. If you don't want something, you can push the X and do it again... (ID 030)</i></p> <p><i>z. I get my work finished now... (ID 050)</i></p>
19. Do you think using Google Docs on your iPads to work together at the same time helps you make a better job of your work? Reasons given.	Improves work speed, efficiency and accuracy.	18	<p><i>aa. I can discuss my work with my parents. They give me feedback... (ID 067)</i></p> <p><i>bb. You can work at home with your friends... and you can help each other (ID 065)</i></p> <p><i>cc. Because if I don't know what to write, you've got a buddy there who can help (ID 028)</i></p>
	Teaches collaboration, help others learn, sharing, working socially.	41	



		<i>dd. Because 2 heads are better than 1 (ID 029)</i> <i>ee. Sometimes Miss M comments on our work after school, and this helps... (ID 011)</i> <i>ff. We can work together to fix mistakes and make comments (ID 039)</i> <i>gg. It's good being able to help others with stuff... you sort of learn yourself more too... and it's good at home when it's not so rushed... (ID 021)</i> <i>hh. It helps me with the ability to work together with other people at the same time... you get better ideas (ID 052)</i>
Assists with homework.	6	<i>ii. I can access homework at home (ID 067)</i> <i>jj. It's where I put my homework (ID 027)</i> <i>kk. You can do your homework with someone else without them being there (ID 065)</i>
Technical (ease of use, storing info, accessible anywhere).	6	<i>ll. It's easy because you can keep your stuff in (ID 083)</i> <i>mm. You can make words bigger or change the colour.</i> <i>nn. It's easier to see (ID 036)</i> <i>oo. It's easy for me to type into (ID 074)</i>
General, non-specific (easier, helps, fun).	28	<i>pp. It helps sometimes (ID 068)</i> <i>qq. Google Docs is very useful (ID 084)</i> <i>rr. Because it helps (ID 076)</i> <i>ss. Google Docs helps me learn (ID 016)</i> <i>tt. It's very important (ID 019)</i> <i>uu. I like using it ((ID 023)</i>

**Table 4.**

Sample data from focus groups

Classification	Question	Response samples (transcribed)
Collaboration through using different apps (in class and remote).	Many comments in the survey told me you thought apps like Google Docs and Edmodo were helpful for working together in your learning.  Can you tell me a little more about why you think this? (plus follow up questions).	<i>a. You can use them to work together... and you don't have to be at school... (FG 1, year 3/4).</i>
		<i>b. Like, if you have a problem or don't know something, you can work it out with someone else. Sam and I sometimes do our homework together, and have Skype going too... so we can talk and see. It's cool! (FG 2, year 5/6).</i>
		<i>c. If we get behind in class we can catch up... and if we aren't sure what to do, it's easy to check with someone else... (FG 3, year 5/6).</i>
		<i>d. It helps us to get feedback on our work... like, if you work with someone else they can give you ideas and suggestions and stuff... that helps you do a better job of it. You don't have to wait 'til you get back to school... and you've probably forgotten all about it... (FG 2, year 5/6).</i>
		<i>e. It helps us to learn to work together... when we get back to school, we can kind of just continue on. I think we get more done... well, I get my work finished now, anyway... (FG 3, year 5/6).</i>
		<i>f. My Dad and Gran can see what I'm doing at school... Dad lives in Auckland and my Gran, well, she's in Australia... but she still helps me... and I can let her know how I'm going... (FG 3, year 5/6).</i>
		<i>g. Google's good for keeping your stuff in... you don't lose things. It's always there if you need to get it... (FG 2, year 5/6).</i>
		<i>h. They're ok... but sometimes they don't work... glitches. Like sometimes if you want to share a link it doesn't work, and you think the other person has got it... but they haven't (FG 2, year 5/6).</i>
		<i>i. It's good being able to choose which app you use to do things. You can do some stuff in one... like, say, Popplet you can plan your story... then you can use Pic Collage or Keynote or something to do it... and when you finish you can share it on Apple TV. It's easy – there's no mucking 'round. And others can see it and give you advice... (FG 3, year 3/4).</i>
		<i>j. I like it how you can change things... (prompt, how?) Well, like Deanna and I were working on our scenario the other day and she spelt 'cyber-safety' wrong... and I knew it was wrong, so I just fixed it! And 'cos we use 2 iPads together on something we can both write at the same time... we do more... (FG 2, year 5/6).</i>
Collaboration in class supported by device attributes.	In the survey you rated some of the features of the iPad that I had seen in the display videos that seemed to be useful for helping you to work together. These were things like (survey list repeated). In particular, you seemed to like how it was light and portable and you could do your work anywhere... that you can lay it down or stand it up to do different things and everyone can see it...	<i>k. It's good being able to work anywhere. Sometimes we go outside and do our work... that's fun... but if the sun's out it's hard to see... sometimes (FG 1, year 3/4).</i>
		<i>l. ... it helps... like you can move around and talk to someone if you're stuck or see what they're doing... show them... and sometimes they can help you... or even fix it with you... you know... on the spot. It's not like having to carry a laptop or something... the screen doesn't get in the way and you have to be real careful. It's more like carrying a book... (FG 3, year 5/6).</i>
		<i>m. I like it how you can put it flat on the floor so everyone can see... but sometimes it can be a bit confusing if everyone wants to do things on it at once... you have to be organised. We usually work out someone to do the typing and others do ideas and stuff, then take turns... we pass it around (FG, 2, year 5/6).</i>
		<i>n. It's good being able to choose sometimes... like... some things we do together and some things we do by ourselves. It depends what we have to do... but even if we use our own iPad we still share... kind of... (laughs)... I just look at what Natalie's (friend) doing anyway... (FG 1, year 3/4).</i>

... and that the screen can be seen from the side, and so on...

I wonder if you can tell me a little more about how these things help? (plus follow up questions).

*o. Sometimes if we are working together we lock the screen (prompt, why?)... 'cos sometimes it's good but other times it can be a pain... it can turn when you don't want it to... it's better just to turn the thing (iPad) 'round yourself... if you have to pass it... (FG 2, year 5/6).*

*p. I dropped mine once and it didn't break... the cover thing... it sort of bounced but it landed on its front and it still didn't break... they must be tough...! (FG 2, year 5/6).*

*q. I like it how we can work on the beanbags... we put it (iPad) on our knees and we can both see it and work together. It's so much easier to do things together... two heads are better than one... (FG 3, year 5/6).*

*r. Standing it up's cool. Like if you want to watch a YouTube or something, you just stand it up and everyone can see... it's like a little TV... but the sound can annoy other kids. Ms M. has got these little things we can use to plug our headphones in to (splitter boxes) so we can all hear it but not the other kids... (FG 2, year 5/6).*

*s. I think the screen's a bit small sometimes... like... really... only one person can do stuff on it... you know... type and stuff... at a time. If you're working with someone else... they can help with what to write and things 'cos they can see, but only one person can do it (input). It's too crowded otherwise. We take turns... usually... or argue about it (laughs) (FG 3, year 5/6).*

**Figure 1.**

Sharing work and receiving feedback via Apple TV





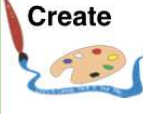





**Figure 2.**

Display visibility supported group collaboration



**Figure 3.**

The School's Learning Values Framework

Reflection Sheet - How am I developing the 6 C's in my classroom?	
<b>Create</b>  Pic collage Minecraft iMovie Keynote	<b>Consume</b>  Google drive Bluster Chicktinariy
<b>Collaborate</b>  Work together Google docs Sports Movie	<b>Communicate</b>  Phone Edmodo Facebook Skype facetime kik instagram
<b>Curiosity</b>  Google safari puffin google Crome When miss Mangino finishes a chapter	<b>Connections</b>  Edmodo Skype facetime kik Instagram messenger

## Appendix A.

### The Survey

5 point Likert scale (response range) and short response questions.

**Theme 1:** *Thinking about how you use iPads in your school work...*

1. How easy is it for you to make changes to your work or edit it (correct mistakes, add or change things as you think of them or after you have finished and so on).... (very hard... very easy).
2. Thinking about how often you do this on the iPad compared with when you did your work in books or on paper, would you do it... (much less... much more).
3. Do you think being able to do this helps you to improve your work? (not at all... all the time).

**Short response:** Please tell me why this is.

**Theme 2:** *You can get a lot of different kinds of information to use for your learning quite easily through the iPad. For example you can get videos, sounds, pictures and graphics, diagrams, maps, words, animations and so on. Thinking about these different kinds of information...*

4. How much do you think they help you with your work? (not at all... all the time).

**Short response:** Please tell me why this is.

**Theme 3:** *You can also show and share what you have learnt in different ways using the iPad, through using different apps like Keynote, Pages, Popplet, ShowMe, iMovie, Pic Collage and so on. Thinking about the different ways you can use different apps to show and share what you have learnt...*

5. How much do you think being able to use different apps helps you to show and share what you have learnt? (not at all... all the time).

**Short response:** Please tell me why this is.

**Theme 4:** *Sometimes your teacher gets you to work with someone else or in a small group when you use the iPads. Thinking about the things below that I have seen in the recordings I have made, how important do you think each is for helping you work together with the iPads?*

*Rate them from 0 - 10 by moving the slider. Numbers will appear as you move the slider. A rating of 0 means that is not important at all, while a rating of 10 means it is extremely important.*



6. The screen rotates so others can see it without needing to move.
7. We can pass the iPad around members of our group because it is small and light.
8. The screen can be seen clearly by others looking from the side.
9. More than one person at a time can touch the screen and do things on it.
10. iPads are small and light and they can easily be carried around the classroom so we can talk to, or share with others, what we are doing.
11. We can use iPads anywhere. We don't have to be sitting at desks.
12. We can lay the iPad flat or stand it up if we need to, to do different things together.
13. We can easily gather around the iPad and see and discuss what we are doing.
14. The iPad has good sound so we can all hear easily.

**Theme 5:** *Sometimes you use Google Docs to work on things by yourself and with others. Thinking about these times...*

15. How often have you used Google Docs *in class* so you can do your work with others using more than one iPad at the same time? (never... all the time).
16. How often have you used Google Docs *at home* so you can do your work with others using more than one iPad at the same time? (never... all the time).
17. How easy do you find it is to use Google Docs and your iPad in this way? (very difficult... very easy).
18. You can use Google Docs and your iPads to work together on your school work *from home* (or anywhere else, for that matter). Do you think you now do... (much less work at home than before... much more work at home than before)?
19. Do you think using Google Docs on your iPads to work together at the same time helps you make a better job of your work? (doesn't help at all... helps all the time).

**Short response:** Please tell me why this is.

**Theme 6:** *Overall opinion*

20. Overall, how would you rate any benefits or advantages there are from using the iPad for your learning? (no benefits... huge number of benefits).

**Short response:** Please tell me why this is.

**Appendix B.****Focus group starter questions.**

(Additional question prompts were made based on student responses).

1. Many comments in the survey told me you thought apps like Google Docs and Edmodo were helpful for working together in your learning.

Can you tell me a little more about why you think this?

2. In the survey you rated some of the features of the iPad that I had seen in the display videos that seemed to be useful for helping you to work together. These were things like *(survey list repeated)*. In particular, you seemed to like how it was light and portable and you could do your work anywhere... that you can lay it down or stand it up to do different things... so everyone can see it... and that the screen can be seen from the side, and so on...

I wonder if you can tell me a little more about how these things help?