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Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Exploring young students' talk in iPad-supported collaborative learning environments

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ARTICLE INFO

Article history:

Received 14 January 2014

Received in revised form

8 April 2014

Accepted 8 April 2014

Available online 24 April 2014

Keywords:

iPad

Collaborative

Learning

Talk

Interaction

ABSTRACT

In the few years since its release, Apple's iPad has generated much discussion about its potential to support student learning at all levels of the education system. Much of this has focused on its physical and technical attributes, such as portability, touch-display, connectivity, and large array of apps. However, a few studies have begun to explore possible advantages of iPads being used as public work spaces, enabling students to interact more collaboratively when creating learning outputs. These studies point to other affordances such as the iPad's ability to lay flat on a desk or be propped at a convenient angle, its wide viewing range and multi-user accessible interface, as being particularly relevant in supporting collaboration.

Between June and November 2013, researchers from the University of Waikato used a specifically developed 'observeware' app to capture display and audio data while young students (5 year olds) were using iPads in pairs for developing numeracy, literacy and problem-solving/decision-making skills. The study used Mercer's (1994) talk types framework to explore the nature of talk students engaged in while they were using the iPads and interacting with each other and their teacher, and also how features of the device may have influenced this.

Results indicated exceptionally high levels of on-task talk, but that this was mostly of an affirming and non-critical nature and unsupportive of outcome improvement or refinement. While the iPad offered unique potential as a shared, public learning device, the pedagogical role of the teacher in realising this by helping students learn appropriate 'ground rules' to raise talk quality, was critical. This article details the methodology used and the results of the study. It discusses the important role teachers play in helping young students build oral-interaction strategies to capitalise on high levels of learning engagement, and the unique features of these devices.

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1. Introduction

1.1. iPads and student learning

Since their launch in early 2010, the iPad has stimulated much interest at all levels of education as a breakthrough or "game changer" (Geist, 2011, p. 758) learning device. Unique features such as its touch screen interface, light and compact form factor, ubiquitous wireless connectivity and wide array of apps, have been cited as offering unique affordances particularly suited to educational use (Dhir, Gahwaji, & Nyman, 2013). While much early commentary took the form of promotional hype or teacher and newspaper stories, recent studies have emerged of a more substantial nature, illustrating outcomes from iPad use in different learning contexts ranging from special education (e.g., Miller, Krockover, & Doughty, 2013) through to tertiary settings (e.g., Cochrane, Narayan, & Oldfield, 2013; Geist, 2011). Other studies have explored their use for particular purposes such as promoting early years literacy (e.g., Falloon, 2013a; Getting & Swainey, 2012; Hutchison,

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Beschorner, & Schmidt-Crawford, 2012; McClanahan, Williams, Kennedy, & Tate, 2012), written language (e.g., Falloon, 2013b) and STEM concepts (e.g., Aronin & Floyd, 2013).

Recently, attention has focused on an observed 'engagement factor' when students use the devices, and how they appear better capable than other technologies such as laptops and desktop computers, to promote learner collaboration. An interesting study undertaken by Fisher, Lucas, and Galstyan (2013) compared using iPads and laptops with student pairs for teaching business calculus. Their observational study of students using both devices revealed significant benefits from using iPads, if learner collaboration is a goal. They determined one of the main advantages was the iPad's ability to support "transition back and forth from private to public work spaces" (p. 165). That is, their design (portability, large screen, multiple viewing angles, ability to be manipulated by more than one person etc.) enabled the device to act both as a private work space and as a "public centre of communication" (Fisher et al., 2013, p. 176). They concluded this supported collaboration throughout a learning task. Laptops, on the other hand, tended to be used more privately, the screen and keyboard in particular acting as barriers to collaboration, leading to the "sharing of information only at the conclusion of a problem" (p. 176). However, they acknowledged limitations to their study in terms of its reliance on observed actions. They suggested that additional research was needed that explored the nature of student dialogue associated with collaborative action, to better determine how device interaction impacts upon the way students discuss mathematics.

Some studies have pointed to perceptions of enhanced learner on-task engagement when using iPads (e.g., Henderson & Yeow, 2012; Manuguerra & Petocz, 2011). Others have offered a contesting view, claiming that the device distracted students from intended learning due to challenges involving unrelated apps and websites (Rossing, Miller, Cecil, & Stamper, 2012), or pop up advertisements (Falloon, 2013a). A recent study by Hoffman (2013) undertaken in a 1:1 iPad classroom explored students' engagement with learning tasks using iPads, and specifically, whether or not their perceptions of levels of engagement (defined as on/off task behaviour) matched observational data. Data for her study of 55 English class students aged 14 and 15 were collected using classroom observation (on/off-task tallies and field notes) and whole class discussion (prompted dialogue on the 1:1 programme and any affect on learning behaviour). Her findings were mixed, and suggested that while students observationally demonstrated high levels of on-task response, this was due more to the perceived importance of the task, the extent to which the task was engaging, and the teaching style of the teacher. Students rated highly personalising the device and the ability to set it up according to individual preferences. They linked this with effectiveness and efficiency by reducing the need to adjust settings or adapt to multiple organisational systems, as was often the case when devices are shared. Countering these, negative comments were made that it was easy to disguise non-learning activity such as messaging or social networking, due to the ease with which apps could be shuffled. Other comments highlighted student difficulties in learning using a visual display – that is, they perceived they learnt better when they needed to "physically write the words out, instead of just pressing buttons" (Hoffman, 2013, p. 15).

Apart from these studies, very little research has been undertaken exploring how device affordances such as those mentioned by Fisher et al. (2013) and Hoffman (2013) may affect the way young students learn when using iPads in pairs or small groups. However, considerable empirical evidence exists demonstrating how learning with and through technology can help develop skills such as student collaboration, interactivity, communication and negotiation, when engaged in socioculturally-based learning tasks (e.g., Goodfellow, 2001; Hollan & Stornetta, 1992; Roschelle et al., 2010; Staarman, 2009; Zurita & Nussbaum, 2004).

1.2. Using talk to analyse student interaction and collaboration

Neil Mercer's early research exploring student group talk while engaged in computer-based learning provided some insights into the nature of their collaboration, and how language they used assisted them (or not) to construct knowledge needed to solve learning problems. In the SLANT project (Spoken Language and New Technology), Mercer (1994) explored "the quality of talk in computer-assisted collaborative activity" (p. 24) to evaluate its nature, and "better understand the role of the teacher in supporting computer-based talk activities" (p. 25). He was also interested in learning more about software design, and its influence on children's talk.

Groups of primary school students were videoed working on a range of curriculum-related computer learning tasks, and an analysis of their conversations was carried out to identify the nature of talk they engaged in. Mercer identified three distinct 'talk types' that he classified as *disputational*, *cumulative* and *exploratory*. Disputational talk was 'argumentative' in nature, where students offered challenge to each other's ideas, but without justification or offering alternatives. Cumulative talk was more conciliatory, and typically represented agreement or continuance without the argumentative elements of disputational talk. Exploratory talk supported reasoning, and displayed student capacity to interact with "the reasoned arguments of others when drawing conclusions, making decisions, and so on" (Mercer, 1994, p. 27). Mercer cautioned against judging one talk-type as being inherently better than the other, as each had its place in the appropriate context. However, he speculated that computer-supported activities designed to promote exploratory talk were the most desirable, given broader educational goals of developing critical thinking and reasoning capabilities.

Mercer also identified four variables that strongly influenced the quality and nature of student talk. These were the physical attributes and design of the hardware, layout and organisation of the equipment, design and content of software, and the nature of the learning task. He commented that it was difficult to extract individual *levels of influence* of each of these variables on student interaction, as each in some way affected the others and stimulated different types of talk. However, an interesting finding relevant to this study was the powerful role of software design in promoting talk of an exploratory nature. Mercer determined that software of an *open design* – that is, requiring students to generate their own content or negotiate solutions to open-ended puzzles or challenges, prompted the most exploratory discussion; whereas software of a closed, highly-structured design (such as games and drills) generated "very little extended, continuous discussion of any kind" (p. 29).

Building on his earlier research (Edwards & Mercer, 1987; Mercer & Edwards, 1981), Mercer (1996) strongly argued that teachers should assist students to develop understanding of 'ground rules' that encourage talk supportive of solving intellectual problems, and the joint construction of knowledge. He described these as "explicit norms and expectations that it is necessary to take into account to participate successfully in educational discourse" (p. 363). Far from being a common sense consideration, Mercer claims understanding how group computer-supported learning (CSL) tasks are carried out, and the oral skills best suited to achieving successful outcomes, need to be made clear, and if necessary, taught, modelled and practised with students. His research revealed that often students involved in CSL appeared to be "operating disparate sets of ground rules for talking and collaborating" (p. 371). He found little evidence of talk suggesting thoughtful

Table 1

The selected apps, description and learning purpose.

App	Description	Teacher-specified learning goal/purpose
Puppet Pals HD	This app enables students to create their own puppet shows and animated stories with recorded audio using a single character set (free version). Other character sets and features (e.g., use of photographs) are available for a fee.	Story recount. Students were to use Puppet Pals HD to reconstruct key events in the plot from a drama production that had visited the school recently (The Big Sad Wolf).
Pic Collage	This app provides an environment for students to construct collage pictures using textboxes, photographs, web images, stickers etc. and to share them via social media, email etc.	Summarising learning from a unit on 'Celebrations' – in this instance, Easter. Students were to create a Pic Collage responding to the question: <i>What does Easter mean for you?</i>
Popplet	This app is a mind/concept-mapping tool designed for young students. They can integrate text, photos and drawings into popples which can be linked into maps, diagrams, charts, lists etc.	Story plan development. Students used Popplet to plan the main features of a story they were writing about themselves. They were provided initial ideas for content headers via teacher-led discussion.

evaluation of information, constructively critical appraisal of others' contributions, or shared decision-making. However, following structured teaching interventions designed to promote exploratory talk, considerable increases were noted, in addition to higher levels of task enthusiasm and involvement. These interventions included learning tasks requiring information and idea sharing, the offering and supporting of assertions and opinions, questioning, negotiating agreement, and collective responsibility for outcomes. Mercer's early work provides insights into the potential of group CSL to construct powerful environments for fostering and extending talk as a "social mode of thinking" (p. 374). That is, it highlights the opportunity CSL environments present for improving the performance of student talk as an aid to joint knowledge construction. However, it alerts that this cannot be taken for granted, and that the teacher has a pivotal role to play to ensure this potential is realised.

Mercer's framework has been used in a recent study by Kucirkova, Messer, Sheehy, and Panadero (2014) that explored the engagement and talk of pre-school children with a story creation app ('Our Story') and a small range of colouring, drawing and construction/puzzle apps. They used a combination of Bangert-Drowns and Pyke's (2001) taxonomy of student engagement with educational software and Mercer's exploratory talk, to interpret video and audio data from forty-one 4 and 5 year old Spanish pre-schoolers, who were using the apps unsupervised during free-choice activity time. Interestingly, their analysis indicated qualitatively different levels of engagement with each type of app. The story creation app appeared to be more effective for engaging the students critically, and in a way that sustained deeper and more challenging interactions. While little difference was noted in the total percentages of exploratory talk for each app type, Kucirkova et al., did note that there was less evidence of *extending* and *challenging* exploratory talk in students' use of the drawing or colouring apps, and less *overall* exploratory talk when students used the puzzle/construction apps. Commenting on possible reasons for this, they speculated that the open-ended nature of the story and colouring apps, and the fact that they had no built-in 'success criteria' (e.g., affective reinforcements) stimulated more discussion, as the children needed to verbally interact to gain feedback and confirmation from peers. Consistent with Mercer's (1994) earlier findings, Kucirkova et al. concluded that using open-ended apps could provide valuable opportunities for children to develop exploratory talk. They also, however, acknowledged limitations to their study in terms of the amount of data collected, the study's duration, and restriction to pre-school environments where use of the apps is generally "uncontrolled and spontaneous" (p. 182).

What follows builds on Mercer's work and that of Fisher et al. (2013) and Kucirkova et al. (2014). It explores young students' talk when using iPads collaboratively in pairs to plan writing tasks and create content for units of learning. It applies a variation of Mercer's 'talk type' framework to examine the nature of their talk, and discusses opportunities for teachers to use the iPad's *public work space* affordance (Fisher et al., 2013) to provide opportunities for students to interact with the device and each other, in a way supportive of developing exploratory talk. It uses a unique display recorder app installed on the iPads to capture video and audio data independent of observer or 'over-the-shoulder' video effects.

1.3. Research questions

The collection and analysis of data was informed by the following research questions:

1. What is the nature of student talk when planning and creating literacy-based content in pairs using iPad apps?
2. How might teachers exploit the iPads public work space affordance to foster talk of a more exploratory nature?

1.4. The research context

Participating students were a class of year 1 (5 year olds) attending a medium-sized primary (elementary) school located in a small town in the Waikato region of New Zealand. The school had a roll of 350 students, with the research class comprising 19 students (10 girls and 9 boys). All students had been at school for between three and six months, and had been using iPads as part of their literacy and numeracy programme. Ten iPad 3s were supplied by the University for the research, having been made available from April 2013 to allow time for the students to become familiar with their operation. The teacher was an experienced practitioner having taught for 17 years in classes from years 1–8, with the last five of these being at year 1.



Fig. 1. Screenshot of typical 'observeware' app recording indicating finger placement (white dots).

Data were collected using a display capture app on seven occasions from July to November 2013. Each session was between 40 min and an hour in duration. The three apps used by the students during data collection were selected by the teacher to be compatible with the learning objectives of her broader literacy programme. She selected apps that the students needed to actively engage with by creating their own content, rather than apps of a 'consumption' design where they merely responded to onscreen prompts or cues, such as in many

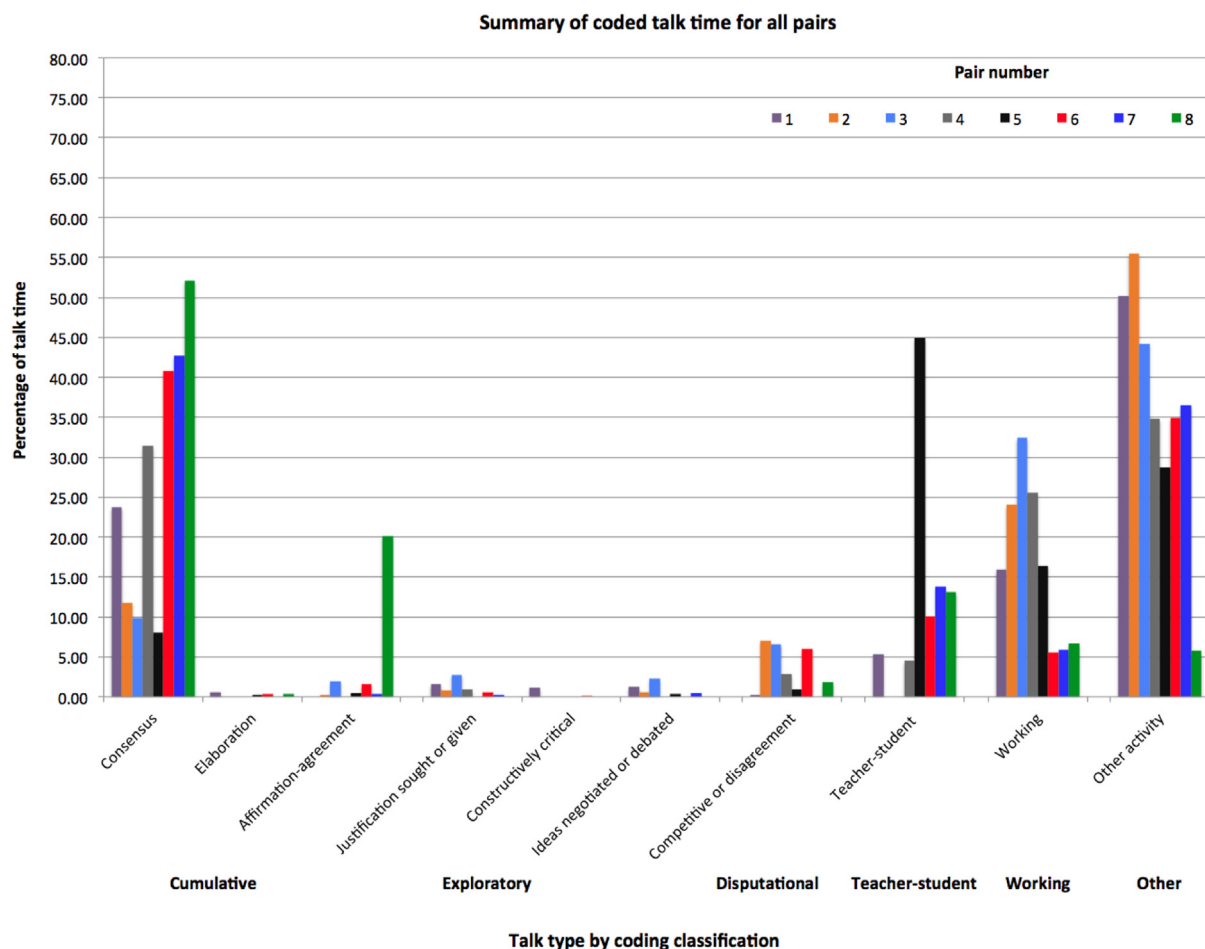


Fig. 2. Summary of talk time analysis of selected episode for all pairs.

Table 2
Talk type classifications, sub codes and descriptors.

Talk type	Active sub code	Talk description
Cumulative	Affirmation/agreement	Talk that is supportive and affirming. Non-critical. Agreement with what was suggested without cause to review or challenge. Passive and compliant.
	Consensus/clarification	Talk that builds understanding of suggestions or ideas but in a non-critical, non-challenging and non-expansive way. Developing common understanding by talking about ideas. Working towards general agreement on course of action.
	Elaboration	Talk that is more expansive, and focused on building the finer detail of how to go about producing or deciding on content. Questions asked seeking further detail about how to do things or clarify why a partner is suggesting a particular course of action.
Disputational	Competitive/defensive	Talk that emphasises person-focused conflict, argument or disagreement, detracting from collaborative effort. Competing for time on device ('my turn, your turn'), verbally interfering with or negatively critical of the other's input. Emotive response is triggered by personal notion of 'unfairness'.
	Individualised	Talk that indicates possessiveness of own contribution. Unwilling to consider other's suggestions for improvement or change.
Exploratory	Critically constructive	Talk that indicates respectful cognitive engagement with, and consideration and critical review of others' ideas in a way leading to improved decision-making or content. Constructive critique focused on the ideas or suggestions, not the person.
	Negotiated/debated	Talk that demonstrates tentative ideas being offered and debated. Student(s) receptive to change, if a good supporting reason(s)/case can be made by other(s). Different perspectives are acknowledged and synthesised into a collective response. Compromises negotiated.
	Justification sought/given	Talk that seeks justification of perspectives or ideas being offered, with a focus on how they will improve decision-making or output quality. Reasons for suggestions are pursued through probing questioning or offering of alternatives.
Teacher–student (active code classification)	N/A	Talk between the teacher and student pairs responding to student requests for help, or formative feedback based on teacher observation while monitoring group progress during work period. Whole class teaching at session commencement or feedback/review at the end, or formative during work session.
Working (active code classification)	N/A	Talk that is often to <i>self</i> while working. For example, self talk involving sounding out words, 'thinking aloud' about content or procedures, reading aloud sentences; or talk related to organising work involving others, such as access to materials (e.g., word boards, spelling lists).
Other activity (active code classification)	N/A	Talk that did not fall into any of the above categories, but was still task-related. For example, teacher–whole class talk (the teacher introducing the app or the task, setting success criteria, teaching technical skills etc.) or sharing and evaluating outcomes at the conclusion of sessions. No student talk was coded in this category.

learning games. In finalising her choices, she accessed online reviews from other users, read commentary from teachers on the New Zealand Virtual Learning Network (see www.vln.school.nz/), and trialled them with her own primary aged children. She selected the following apps to help meet the learning purposes specified (Table 1).

1.5. Data collection

Data were collected using a unique display capture tool adapted from developer code associated with a Cydia App called Display Recorder. The 'observeware' app records in the background while students are using their apps, creating a video (with audio) of all display activity. This can then be downloaded onto a laptop for later analysis, using a root file retrieval application. No signs of recording apart from a finger placement indicator (a white dot on the display) are visible to the students. A typical recording screenshot including finger placement indication can be seen in Fig. 1. Further details of the tool and methodology have been reported elsewhere (see Falloon, 2013a, 2013b).

The 19 students worked in teacher-assigned pairs and one group of three (forming eight pairs and one threesome). Across all groups a total of nearly nine hours of video and audio were recorded. This comprised two or three separate sessions for each pair, usually of between 20 and 30 min each in duration. Data sets for each pair could easily be collated, as the composition of the pairs remained the same throughout the study. From each data set, one episode was selected for talk-type analysis. They were purposively selected after an initial appraisal of all data, to illustrate the best-recorded evidence of different talk types 'in action'. The results for all pairs are summarised graphically in Fig. 2.

1.6. Data coding

It should be noted at this point that Mercer's original framework was developed using data from slightly older students (8–11 years). While his broad classifications of disputational, cumulative and exploratory talk are used here, a slightly different coding regime to that used by other iPad studies adopting his framework (e.g., Kucirkova et al., 2014) has been applied. This is to accommodate any differences in the nature of evidence younger children may provide – specifically, the complexity and sophistication of language used, and taking into account the way in which intent or meaning is communicated (e.g., tone of voice, expression etc.). For this reason, coding decisions were made using sub codes defined by detailed descriptors generated from data, which were then aligned more specifically with Mercer's classifications (Table 2). Instead of using only keywords, evidence was expanded to include phrases and whole sentences that were judged to reflect interactions consistent with the descriptors, and aligned with the sub codes. Examples of these are included in the sample data tables (Tables 4–6).

During initial coding, all data sets (episodes) were reviewed several times to fully understand the nature of talk occurring, and its relationship to Mercer's classifications. From this, sub codes and descriptors were generated (Table 2) that formed the coding template that

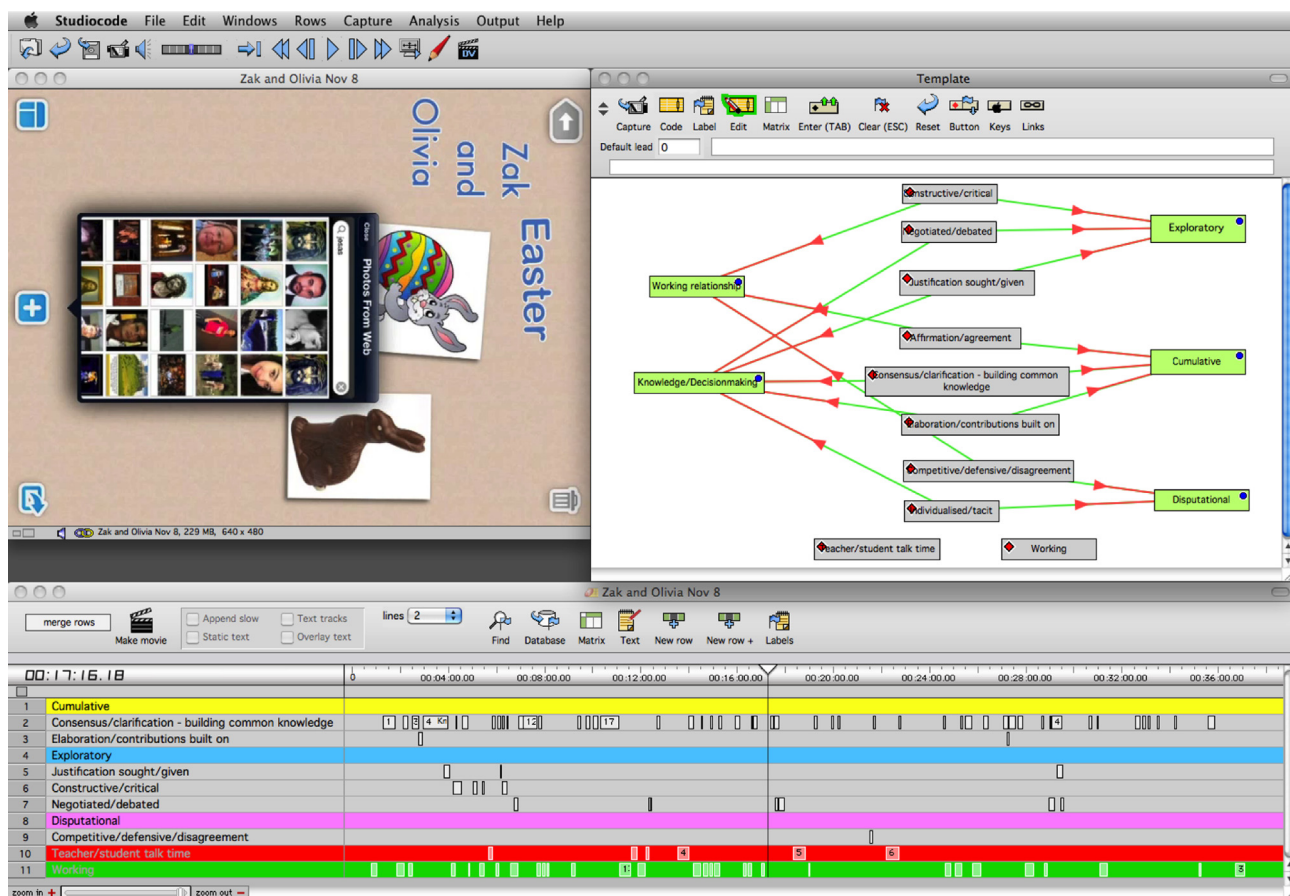


Fig. 3. Sample Studiocode template and timeline (Pair 1).

was applied to the selected episodes. Studiocode video analysis software² was used to code these. Using Studiocode meant that detailed transcription was not needed, as selected clips aligned with the sub codes are automatically arranged on timelines and can be individually or collectively reviewed at will.³ For the purposes of this article, selected verbatim excerpts from these recordings have been included in the data tables.

The sub codes were entered into a Studiocode template that was applied to the selected episodes. Two non-active labels were added to the template (*knowledge/decision-making* and *working relationship*) as well as three active talk type classifications (*teacher–student*, *working* and *other activity*). The former were added as additional non-active descriptive labels that variously linked to the different talk types, while the latter were active code buttons allowing coding of recorded talk other than that aligned with Mercer's original classifications (and their sub codes). Specific details and descriptions of the sub codes expanded from Mercer's talk-types framework is provided in Table 2, and samples of data coded under each are included in Tables 4–6.

An example of the coding template as applied to Pair 1's episode can be seen in Fig. 3. The sub codes and the added classifications were active buttons, and registered on the timeline an event in the video aligned with the particular code or classification. Studiocode also produced statistical summaries of data giving the total times aligned to each code, the number of occurrences, and the mean occurrence time. Summaries for the three illustrative episodes are included in Appendix A.

To support coding reliability, an excerpt from a single data sample for three pairs (1, 2, & 8) was blind reviewed by a post-graduate research assistant. Inter-rater agreement calculations (κ) for each of the three main talk type classifications are provided in Table 3. Following Gwet's (2012) advice, calculations were made only on instances both coders had identified, to lessen the likelihood of an underestimation of agreement probability. While agreement calculations were not completed for the sub codes, occurrences from the excerpts were debated, with eight changes to coding decisions subsequently being agreed upon. According to Landis and Koch's commonly-used scale, agreement strengths ranged from moderate to substantial across the three main talk types (Landis & Koch, 1977).

2. Results

Fig. 2 summarises coded data from the selected episodes of each of the eight pairs. It indicates the percentage of talk time coded under Mercer's cumulative, exploratory and disputational classifications, and the sub codes used for making coding decisions. Additionally, it includes time percentages for talk involving interaction between the teacher and the students, working talk, and other activity.

² Refer www.studiocodegroup.com.

³ For comprehensive detail of this process, refer Falloon (2013a, 2013b).

Table 3
Inter-rater agreement calculations (κ).

Talk type category	Total 'agreed to' instances identified in all excerpts	Kappa (κ)	SE	95% CI	Agreement strength (Landis & Koch, 1977)
Disputational	8	0.750	0.226	0.306–1.00	Substantial
Cumulative	46	0.609	0.117	0.380–0.838	Moderate
Exploratory	14	0.708	0.191	0.334–1.00	Substantial

Task time coded as 'other activity' was substantial for seven of the eight pairs. However, on average, nearly two-thirds of this time was spent either on introductory or during-session teaching (i.e., the teacher introducing the app or the task, setting success criteria, teaching technical skills etc.) or sharing and evaluating outcomes at the conclusion of sessions. The remaining one-third was divided almost equally between no talk but working (i.e., silence, but display-recorded evidence of on-task activity) and non task-related talk. This latter category accounted for slightly less than 7% of total task time, indicating very high levels of on-task engagement by all pairs.

Across the three main talk type classifications, the highest percentage of student–student talk for all eight pairs was coded as cumulative consensus (e.g., 52% for Pair 8), followed by cumulative affirmation/agreement (e.g., 20% for Pair 8). Disputational (competitive/disagreement) talk peaked at 7% for Pair 2, while exploratory totalled just under 4% for Pair 1 across the three sub codes (justification, constructively critical, negotiation).

Although data from all eight pairs were coded, three pairs (1, 2 and 8) have been selected as illustrative examples within each of the classifications (cumulative, exploratory, disputational) and their sub codes. They most aptly demonstrated the different talk types the eight recorded pairs engaged in. They also represent student interaction with all three apps that were used during data collection. The student pairs were Pair one (exploratory emergent), Pair two (intermittent disputational) and Pair eight (cumulative dominant). Studiocode summary data for each are presented in [Appendix A](#). Illustrative data from display recordings for each pair are included in [Tables 4–6](#). The tables comprise a description of the activity or task the students were doing, verbatim transcripts of the recorded dialogue with associated timelog, and a corresponding thumbnail image from the display recording. The timelog relates to the time location in the display recording the illustrated example refers to, as registered on the Studiocode timeline (see [Fig. 3](#)).

3. Discussion

Student talk data demonstrated exceptionally high levels of on-task engagement, but much of this was cumulative in nature, with only pairs 1 and 3 (at approximately 3–4% of total talk time) displaying any tendency to engage in exploratory talk. Correspondingly, coded occurrences of disputational talk were also minimal, with only pairs 2, 3 and 6 (at 6–7% of total talk time) showing any competitive, defensive, or argumentative talk behaviour. These results are very encouraging, and highlight the potential of collaborative learning environments supported by iPads to generate opportunities to raise the quality of student talk. However, the lack of exploratory talk suggested much of this potential was unrealised. The predominance of cumulative talk created something of an 'echo chamber-of-affirmation' effect, where students progressed tasks smoothly, generally through non-critical agreement with their partner, or by adopting work practices characterised by device 'turn taking'. This generally meant one student at a time worked on the task while the other observed and/or acted as a checker or affirmer, before swapping roles and repeating the process. Pair 8 (e.g., [Table 6](#), 6.40–7.22) is a good example of this practice in action.

Despite being collaborative in the sense that there were few disputes or disagreements, the assenting nature of cumulative talk was not focused on, and did not encourage or support, critical review or explanatory justification of ideas. Instead, it fostered a cycle where a suggestion or idea was verbalised usually by the author, and agreed to by the other, who then adopted an assistant or advisor role. During cumulative talk occurrences, data indicated the iPad acted as a private-public learning device. That is, it served as an individual authoring tool and as a public work space both students could access and interact with (see [Fig. 6](#)). Its affordances of lying flat on the desk or tilted conveniently using the fold-back case, ease of portability, wide viewing angle and accessible built-in keyboard, meant that both students, if they wished, could play a role in authoring outputs. However, these affordances did not necessarily mean that this occurred.

Although it was not the intention of this study to compare 'before and after iPad' results, as Mercer points out, the development of exploratory talk should be integral to the role of educational institutions in societies where principles of "accountability, clarity, constructive criticism and receptiveness to well-argued proposals" (1996, p. 370) are valued. The desirability of developing skills of this nature is also reflected in other literature relating to 21st Century learners (e.g., [Ananiadou & Claro, 2009](#); [Gilbert, 2005](#)). It seems reasonable, therefore, that opportunities to evolve cumulative talk into talk of a more exploratory nature, should be recognised by teachers and capitalised upon.

Overall talk occurrences coded as disputational were minimal. However when they did occur, they generally represented competitive interaction between students for control of or access to the device, or the prioritising of one's ideas over those of their partner (e.g., [Table 5](#), 4.01–4.14; 5.40–5.51). This talk was sometimes associated with low-level physical and/or verbal confrontation, where students argued over such things as device access time, whose idea was better (for content or 'how to do it') or physically manoeuvred themselves or furniture so they could have unfettered access to the iPad (e.g., [Table 2](#), 10.53–11.32). Disputational talk was generally unproductive for achieving learning goals. Instead, it was aimed at maximising an individual's 'elbow room' to increase their access to the iPad and influence over the task. Disputational talk occurrences were associated with competition for private work space access to the device. Display captures often recorded multiple finger placements, with the audio indicating students were physically competing with each other for the iPad, and to have their ideas prioritised in the output. During these few occurrences interaction became a battle of wills, with the victor usually ending up as the sole author and their partner a passive observer ([Fig. 6](#)).

As with disputational talk, very few pairs demonstrated talk coded as exploratory. However, that which was (mainly Pairs 1 and 3) indicated an emerging capability and willingness to engage cognitively and critically with ideas, concepts and suggestions, rather than focus their talk attention on their partner (e.g., [Table 4](#), 4.11–4.33; 29.01–29.36). At a basic level this was illustrated by questioning and audio suggesting a desire to improve or refine outputs, or offer alternative options and justification for their inclusion. At other times this talk

Table 4

Pair 1: O and Z (Pic Collage. Nov 8, 2013) coded exploratory emergent.

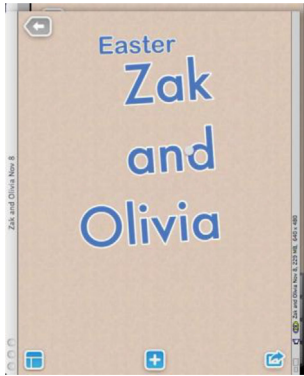

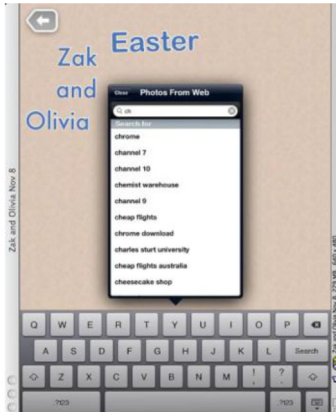
Thumbnail	Description of activity and coding	Recorded dialogue and time
	Exploratory: justification Celebrations topic: Easter. This task was part of a 'Celebrations' topic the students were completing. They were developing a Pic Collage of what Easter means to them. At this point they were naming their work.	3.50–4.05 "O...l...iv...i...a... (correct spelling of name appears in pop up). How does it know my name and not yours? ... that's not fair, is it Zak? Why did it do that, Zak? (O) What did you do? (Z) I just started to spell my name and it came up... (O) Show me how you did it..." (Z).
	Exploratory: constructive/critical Activity as above. Students had selected first picture and were developing title/label.	4.11–4.33 "I think we'll put it there... now, shall we do our four pictures? How do you celebrate Easter Zak? (pause)... how do you do it? Do you have chocolate...? I really think we need to have chocolate, Zak... (O). I wonder why chocolate... why do we have chocolate? (Z) 'Cos it's what eggs are made from..." (O).
	Exploratory: constructive/critical Activity as above. Students were using app's built-in web search to find Easter pictures.	4.56–5.09 "Is that how you spell chocolate...? I forgot something... 'I ate'... (Z) No... I know how... but just leave the 'ch'... think about how it sounds Zak... ch... ch... o... c (O – begins to sound out word). You have to think about how it sounds, Zak..." (O).

Table 4 (continued)

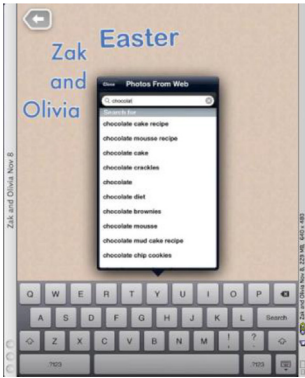

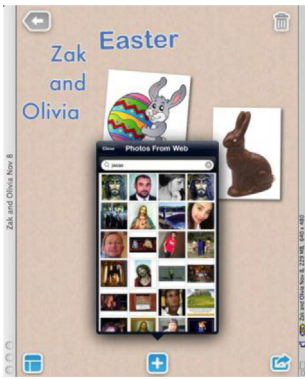
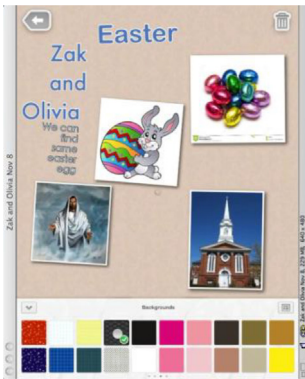



Thumbnail	Description of activity and coding	Recorded dialogue and time
	Exploratory: justification/constructive-critical Activity as above. Students were deciding on search terms for Easter images. They were debating the most appropriate search terms to use.	6.09–6.22 “No... do you want chocolate eggs or not?” (O). Just chocolate... shall we put just chocolate? Do we have plain chocolate at Easter? (Z)... What do you mean ‘plain chocolate’? (O) Well, you know, normal stuff! (Z) What’s normal? (O)... Let’s pretend this is a rabbit...” (Z).
	Exploratory: negotiation/debate Activity as above. Students were deciding on the images to include on their Easter pic collage. Z had located a chocolate rabbit he felt would be suitable and was discussing the choice with O.	6.43–6.56 “Let’s have this one (Z – indicating a chocolate rabbit by ticking the ‘select’ box). We don’t want that, do we? (O) Yeah, that’s a... (Z). Let’s have this one? (O – selecting a second option). Why? I like this one (Z – indicating first option)... it’s a real bunny... not like the others...” (Z).
	Exploratory: negotiation/debate Activity as above. Students were trying to find a picture of Jesus to put on their collage but had been unable to spell the word correctly despite numerous attempts. Incorrect spelling resulted in unrelated images.	11.27–12.20 “Shall I try to write ‘Jesus’? (O)... Yes, why don’t you give it a try? (Z)... ...Zak, we do need this you know (referring to picture of Jesus)... shall I write it again so we find a Jesus? (O)... Good idea (Z)... (O types ‘Jesas’ in search box – returns only a few pictures of Jesus). Oh... why are we still on this? (O). I’ll go get Mrs. Fenemor!” (Z)
	Exploratory: negotiation/debate Activity as above. Students are discussing the positioning of their images and what size they should be. They are also working out whether a plain or patterned background is best, and experimenting with different options.	29.01–29.36 “We can put it there (Z)... That means it’s right next to our church (O)... We could do it littler... what do you think? (Z)... We can find some Easter eggs (O)... Shall we change our background? We chose that one... then we end up getting a plain one – which one might be best? (Z) The plain one’s easier to see (O)...”

Table 5

Pair 2: A and H-M (Puppet Pals HD, Aug 23, 2013) coded intermittent disputational.

Thumbnail	Description of activity and coding	Recorded dialogue and time
	Disputational: competitive/defensive Puppet Pals supports development of animated puppet shows using standard characters (free version) or imported graphics (paid-for version) Students were developing a puppet show retelling the story of a live production (The Big Sad Wolf) that had just visited the school.	2.29–2.37 “No... I don't want it! (referring to partner's selection of a squirrel as a character substitute). I like that one... do that one! (selecting fairy godmother image) (H-M)... But I like the squirrel... so we're having it!” (A).
	Disputational: competitive/defensive Activity as above. Students were working out where to put their characters and the relative sizes they needed to be to indicate distance and perspective.	4.01–4.14 “Make the wolf smaller (referring to squirrel substitute). I want you to make him smaller... and make him smaller, too (referring to soldier) (A)... No! She needs to be bigger (referring to princess)... if we make her bigger then the others will look smaller... (H-M). Look... just make them smaller... all right!!” (A – exasperated).
	Disputational: competitive/defensive Activity as above. Students were disagreeing on who was to resize the princess and where she was to be positioned in the forest.	4.57–5.11 “Here, let me do it... I'll do it! (A – touching display with 2 fingers). You're not letting me do it... why do you do that to me? (H-M) “Cos you're always having turns ... it's my turn now ...” (A).
	Disputational: competitive/defensive Activity as above. Students continued to disagree on where the princess was to be located, and her relative size.	5.40–5.51 “I know how to do it... (resize the princess). You need to let me have a turn! (H-M). You can't just... (H-M places 2 fingers on display in attempt to take over)... let go! It's not your turn! (A)

Table 5 (continued)

Thumbnail	Description of activity and coding	Recorded dialogue and time
	Disputational: competitive/defensive Activity as above. Students were disagreeing about who should do the wolf's voice over as they were developing the commentary for their show.	10.53–11.32 "You said I could be the wolf... ! (H-M). But you're just lying...! (A). You said I could be the wolf! (H-M). But now we can't, 'cos we've done it like this... (A – reminding that she had done wolf's voice until then). OK!!! (H-M – exasperated). It's because I'm sitting in the chair (A)... But you don't own the chair... ! (H-M) I need to move the chair over here... to be in front of you... (pause) now... I'm in front of you... (A) No it isn't... !" (H-M)
	Disputational: competitive/defensive Activity as above. Students were disputing who should record the judge's (fairy godmother substitute) voice over.	13.12–13.21 "No, you don't say it... ! This is the judge, remember... (referring to the fairy godmother)... you don't do that! (A). Yes I do – you can't do all the good bits... !" (H-M)
	Disputational: competitive/defensive Activity as above. Students were unsure about procedure to save their work. H. was suggesting experimenting with 'save' button at top of pane.	14.44–14.55 "You don't do anything until Mr. Falloon gets back... we need to ask him how to do it (A – referring to saving their work)... I'm telling Paige on you! (another student). You get to do all the good stuff!" (H-M)

indicated a genuine concern for, and a willingness to support the learning of the other (e.g., Table 4, 4.56–5.09). This reflected in recorded comments clarifying why particular decisions should be made, and others aimed at helping their partner understand the operation of the app they were using (e.g., Table 4, 3.50–4.05).

The public work space affordances of the iPad appeared to assist these students to collaborate in this way. Often they were observed passing the device from one to another or sliding it along the desktop. The display recordings indicated they were usually seeking comment or advice from their partner about possible inputs, or getting them to check that what they had written or selected was what was agreed upon. On other occasions display rotation was used, so that a partner seated opposite or adjacent could more easily view and interact with content, without needing to relocate (Fig. 4). The wide viewing angle also allowed both students to access and simultaneously interact with content (Fig. 5). Several examples of both students making 'on the fly' changes to content were recorded, with multiple white dot finger placements being visible.

Unlike students whose talk was coded disputational, accompanying audio indicated the simultaneous interactions of students coded as exploratory (Pairs 1&3) were directed at improving work or demonstrating techniques, rather than competing for device access or prioritisation of ideas. While the public work space affordances of the iPad undoubtedly supported exploratory talk for Pairs 1 and 3, it is doubtful that they were the impetus or cause of it. All students had access to the iPads in the same way for completing the same tasks, but most did not display observable tendencies towards exploratory talk. What is relevant is that for those few who did, the iPad appeared to support their endeavours, suggesting potential exists for exploiting these affordances to improve the quality of the working talk of others.

Fig. 6 reflects the talk classifications and the implicating roles played by students and their devices within each, relative to the nature of their collaboration. Increasingly sophisticated talk is observed when students progress from the right to the left side of the Figure (i.e., from disputational to cumulative to exploratory). From this, it can be inferred that the nature of student knowledge generation/decision-making

Table 6

Pair 8: N and L (Popplet, Aug 12, 2013) coded cumulative dominant.





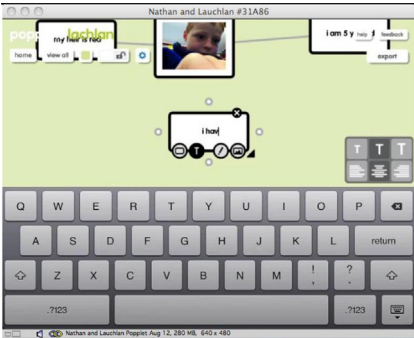
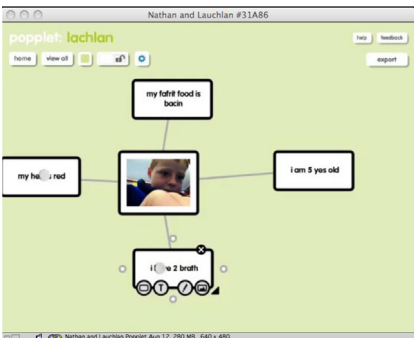

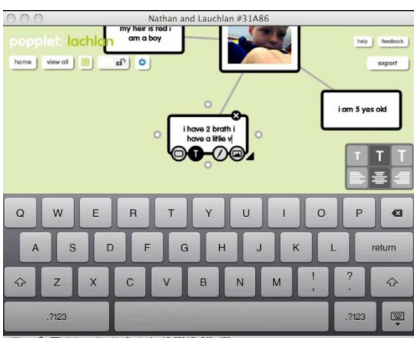
Thumbnail	Description of activity and coding	Recorded dialogue and time
	Cumulative: consensus Students were developing concept map plan for a story they were to write about themselves. They were working in pairs developing one plan at a time. At this point they were writing about physical features and appearance.	0.14–1.35 “What shall we write? (N). What colour is my hair? (L). It’s red (N). Find ‘M’ (N)... (N types ‘N’)... That’s ‘N’ (N)... backspace (L)... M... y... h... e... i... r (L spells aloud to self). Do I do everything? (L)... I’ll do spaces for you (N)... L... s... r... e... and the d” (L spells aloud to self).
	Cumulative: affirmation/agreement Activity as above. Students were summarising statistical information such as age, height etc., following prompt from teacher.	3.03–3.35 “Y... where’s ‘y’ gone? (L)... I’ll move your finger... there (N)... ... e... space... o... l... d (L)... OK, now pick up they grey circle and drag it to your picture... that’s good... right... now tap here (indicates to tap on link point)... that’s it... you’re doing it right...” (N).
	Cumulative: affirmation/agreement Activity as above. Students were summarising favourite foods and drinks in their plan.	4.42–5.20 “My favourite food is macaroni cheese with bacon (L)... Yeah... that’s nice... and bacon... but you can only have one... which one? (N). ... bacon (L). Good choice! (N)... ...M... y... f... a... f...” (L).
	Cumulative: consensus Activity as above. Students were continuing developing content on favourite foods and drinks.	6.40–7.22 “It’s d... not t... d! (N)... space... i... S... space... b... a... a (L – spelling to self)... No... it’s c... not another a... (N)... OK (L)... i... n (N). Now... join it up! (N)... Like this? (L)... OK... that’s how we do it” (N)...

Table 6 (continued)

Thumbnail	Description of activity and coding	Recorded dialogue and time
	Cumulative: consensus/clarification Activity as above. Students were recording details of other family members.	9.13–10.30 “T (N)... What should I do? (L)... You choose (N)... What? (L)... I've got 3 boys in my family (L)... I've got 2 brothers (N)... I... h... a... v... e... (L – spelling to self)... Where's the e gone? It's here!” (N – indicating)...
	Cumulative: consensus/clarification Activity as above. Students continuing recording details of family members.	11.27–12.20 “B... r... a... t (N – spelling aloud for L)... th? (L)... t... (N)... h... t... h... (N)... I did !th (L)... OK, tap there (N – indicating to tap on Popple)... join... I joined it up (L)... Yep... now you have to make it... in” (N)...
	Cumulative: consensus/clarification Activity as above. Students have swapped roles and are now creating the second story plan Popplet. They are recording details of the second student's physical features (hair).	14.43–14.54 “Right... I just made it fatter (N – referring to text box)... Why?... why did you make it fatter? (L)... To fit it all in... the words... it wasn't big enough... (pause) my hair is black... bl...a...k” (N – sounding word to self)
	Cumulative: consensus/clarification Activity as above. Students have swapped back and are making final changes to Popplets before saving to share with class.	21.35–22.08 “L... i... t... (L – to self and typing)... t... t... t (N)... l (L)... e... space... b... not d... it's b (N, to L)... Oh... that's v... where's b? (L) b... r... a... a! (N, to L)...

and their *working relationships* are also shaped accordingly. When students undertake or experience more exploratory talk (or conditions are established to encourage them to do so), they begin to appreciate others' constructive and critical perspectives and how they may contribute to their own learning. They can likewise contribute to that of others – that is, moving from closed tacit understandings, towards establishing common knowledge and being more open to negotiation of ideas. Their working relationship with their partner in turn changes from competitive, to that of affirming and being critically constructive of each other. In this movement, the device's role, nature of



Fig. 4. Display rotation supported collaboration.

collaboration and students' role, also shift respectively, from private to public work spaces, from minimal to more open collaborative learning partnerships, and from single learner to multiple learner-constructed outputs. We posit a crucial aspect facilitating this shift lies in the notion of 'ground rules'.

3.1. Establishing and learning ground rules

Drawing on [Mercer and Edwards \(1981\)](#) concept of 'ground rules', it seems apparent that if teachers are to capitalise on the public work space affordances of devices such as iPads for raising the quality of work talk (i.e., towards exploratory), then some ground rules need to be developed. What is interesting from this study is that a few students showed glimpses of exploratory talk *without* any explicit teaching or practice of ground rules. This suggests that targeted teaching could help harness a latent potential existing in these learning environments, to support better quality talk contributing to collaborative knowledge construction. Although these students were only 5 years old, already some of them displayed thoughtful, task and ideas-focused questioning skills that concentrated on improvement and refinement of their work – not on a personal critique of their partner (e.g., [Table 4](#), 6.43–6.56). Learning activities promoting and practising questioning that respectfully probes for justification and seeks explanation, may be a useful strategy for achieving this.

Additionally, encouraging thoughtful listening to others' ideas and objective reflection on them relative to task goals, should be promoted. Exploratory talk does not appear to thrive in environments where ideas are exclusively 'owned' or are placed in competition with each other. Students should be encouraged to understand the need for 'depersonalisation' of talk in situations that require open and objective consideration of ideas to improve outcomes, while also understanding that this may not apply in every context. Although such dispositions could be difficult to formally teach, teacher modelling of them and capitalising on 'teachable moments' during normal classroom work where they could be highlighted, could be valuable.



Fig. 5. The touch interface and screen viewing angle supported collaboration.

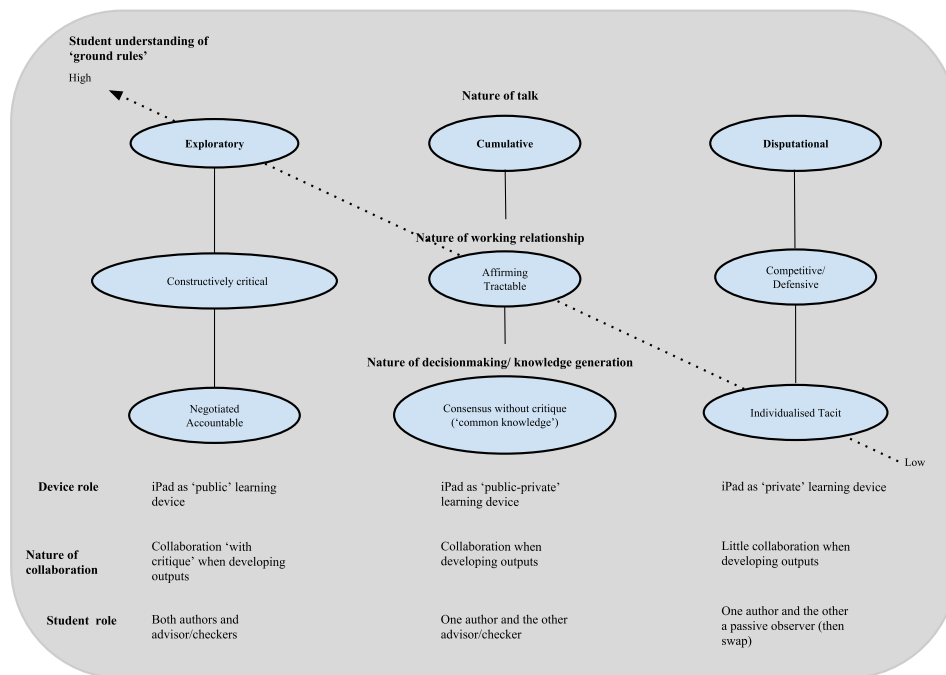


Fig. 6. Talk type, student and device role, and nature of collaboration.

Mercer (1994) alluded to the importance of equipment organisation in establishing computer-supported environments supporting quality student talk. Results of this study indicate an important ground rule for teachers might also relate to *student* organisation. Acknowledging that no specific baseline data were collected, it could be speculated the very high level of on task talk and engagement across this group was at least partially attributable to the stability of pair combinations. These pairs remained constant for the entire study, and according to the teacher, were unchanged from initial pairings established when the iPads first arrived. Informal observations certainly indicated seamless and smooth transitions from class teaching to paired iPad work, with little apparent need for negotiation or competition between students over 'who does what'. Teacher comments suggested early establishment of ground rules regarding expectations of how students are to work together, and careful and deliberate pairing selections that remained constant throughout the year, may be helpful in maximising learning time. However, further research is needed to determine conclusively if this is the case.

4. Conclusion

Earlier studies by the first author using similar data collection methods explored the influence of app design and content features on young students' learning pathways (Falloon, 2013a, 2013b). While having different foci and analysis frameworks, results suggested particular app design and content features had a significant influence over the 'learning value' students could derive from using them, and the sort of strategies they applied to solve problems they presented. Although not applying formal talk analysis, conclusions in these studies were drawn from very careful scrutiny of display video and audio data that indicated the *quality* of oral exchanges between students was strongly influenced by the design of the app, and was also fundamental to building knowledge needed to successfully negotiate its demands. However, both these studies were undertaken with apps of a 'closed' design – that is, game-like apps where students were required only to fill in answer boxes, complete patterns and so on. When reflecting on these results, it would be fair to state that much of the recorded talk was of a low level nature – that is, principally targeted at students *getting the right response* rather than *building their own unique response*.

The talk recorded in this study was qualitatively different. While relatively 'neutral' cumulative talk predominated, it still represented a far more thoughtful, purposeful and cognitively-focused interaction than that witnessed in the earlier studies. It was apparent that the open nature of these apps, combined with the greater public work space affordances of the device, at least potentially could provide students with powerful environments supportive of critical but collaborative content development, as gauged by increased exploratory talk. The combination of iPad design features discussed earlier, and the content generation requirement of open-design apps that stimulates student interaction, appears to provide teachers with an ideal medium through which to build student talk quality.

The superior performance of open design apps in this respect is consistent with the earlier research of Kucirkova et al. (2014), and extends their findings by identifying particular physical and technical attributes of the iPad that when used in pairs or small groups, might support development of this talk type. A key finding of this study is that the interaction and combination of iPad design features (i.e., its public work space affordances) and open-design apps, can provide a useful medium for teachers to improve the talk quality of students. However, the key to unlocking this potential lies in helping students master skills supporting exploratory talk – if necessary, by deliberate teaching acts targeted at these. iPads and apps may constitute motivating and engaging skill-practise environments, but students still need a basic toolkit of strategies and capabilities to apply to them. Helping students build these skills is where the teacher's pedagogical role is crucial.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.compedu.2014.04.008>.

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