Pass the iPad: Comparing collaboration on paper and screen

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Abstract
Multi-user touch devices are increasingly used in educational settings, but primarily for individual work. Do they lack the flexibility and support for groupwork provided by paper? We compare a 'picture consequences' game, private work to construct a shared product, on paper and with iPads. We describe how the two media support shielding private work, showing the resulting group product and sharing group decisions about it. We found some cross-medium similarities and propose development of further group apps for tablet devices.

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H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Interactive displays have been designed to support either single-user interactions (e.g., iPods, PCs, cell phones) or multi-user interactions (e.g., multi-touch tabletops, interactive whiteboards, tangibles). The latter have begun to support new ways of *simultaneous* collaborative work. Devices such as the iPad offer further possibilities for groupwork, and in particular, flexible switching between individual and groupwork. Current use of such technology in schools [1] is either individual, such as digital textbooks or games, or apps mimicking computer games that are more portable. There seems to be little educational use of apps designed for two users working constantly alongside each other, as in chess, and less discussion of their possibilities for groupwork other than the sharing of individually-created products. Why have possibilities for group work not been aired? People naturally use technology in shared ways, even with devices designed to be personal [5]. Thus, mobile learning has

flourished, with people handing over devices and 'shoulder-surfing'. If tablets are not being widely used for group work, we need to assess their potential strengths and weaknesses for supporting collaboration.

Typically, technology is used alongside other media, and paper in particular remains a resource that people continue to use in concert with technology [7]. Tablets have been proposed as 'scrap computers' by analogy with 'scrap paper' : not 'personal' or owned, but flexible work spaces for specific tasks. Do tablets have the same affordances as paper or are qualities lost when using tablets without paper for groupwork?

Background

Collaborative work is not always uninterrupted sharing, but involves frequent switching between working by oneself and with others as the task and situation demands. Moreover, work activities shape themselves as they evolve, often in unexpected ways. Some-times people will work together with great benefit, but there will also be times for individual work. Paper is an excellent medium for such flexible working, easily viewed, transferred and manipulated for individuals and the group.

Trying to collaborate around a computer designed for single use can be hard [4], hence the advent of single display groupware [8]. Multiple input devices (e.g., mice, pens) were added to a single computer so users could independently or collaboratively control multi-user software on a shared display. Separate input and output devices have been combined to support co-located collaboration, such as PDAs with whiteboards, and tangibles with tabletops. Systems built to encourage moving from individual to collaborative working include Geney [2] – linking multiple PDAs combining individual and shared display spaces, CARETTA [9] – combining RFID sensing with individual PDAs for urban planning, and MUSHI [3] – a shared tablet PC and PDA ecosystem simulation. But these integrated systems come with an attentional overhead; users have to switch frequently between the current state of information on their handhelds and the changing state represented on the shared display. Some users may hence choose to work more on their own PDA, and less in the shared space. Large shared surfaces can be demarcated to give personal space alongside shared, but this can encourage territoriality [6], and in turn, more individual and parallel working.

Table 1: Types of personal and shared devices support individual (I) and group (G) working

Personal device (I)	Shared multi-user display (G)	Pers. Device + multi-user display (I+G)	Pers.+ shared display, same device (I+G)
PC, PDA, smartphone	Whiteboard, tabletop	Tabletop + PDA, PC	iPad

The last cell in Table 1 shows how form and function can lie in the same device, e.g. an iPad, so as to flip readily between personal and shared, enabling more fluid transition between individual and group working.

Design

Our collaborative game was an interactive version of Picture Consequences, a pencil and paper parlor game involving individually drawing a figure part, starting with the head, folding the paper over to hide the

drawing but leaving neck lines to support continuity, then passing on to the next person, who draws the torso in ignorance of the head, in 4 rounds (head, torso, legs, feet). Each step is completed privately, and players can *shield* their drawing from others. At the 'feet', the stage shifts from private to public: someone unrolls the paper and *shows* the completed figure (the 'reveal') and the group can *share* a true group creation. To assess the use of group products beyond the ephemeral product of a parlor game, we added a group task here. Players made up a name for the completed picture and chose a sound effect for it.

The picture consequences iPad app (see Fig.1) had simple on-screen instructions. Players used the whole screen and when finished, pressed a button to hide the canvas except the neck, body or leg lines.

Fig1: Picture Consequences App for the iPad

On the reveal, groups could write in a character name and choose from 20 sounds. For the paper version, players were given 4 sheets of paper, a shared tin of coloured crayons, a sand timer and stopwatch. Two family groups (F1, F2) played the game on paper and then on the iPad.

FINDINGS

Shielding -- the individual drawing: For both media, participants were engrossed in their work when drawing. Shielding differed by family rather than by technology: F1 used exaggerated hiding of the paper, with their non-drawing arm, easily replicated with the iPad by holding it out of others' view. F2 did not hide with either medium, having their drawing in view on the table, and looking round for ideas.

Showing - the reveal: Again, differences appeared by family but not medium. F1 took strict turns to reveal for both media, whereas F2 was unstructured, each person revealing for themselves, but then holding the result up for display in a very similar way for iPad and paper (Fig.2). There were similar moments of shared attention and enjoyment at this stage for both media.

Shifting: The different ways of working as a group and individually were clearly marked by the placing of paper or iPad on the table by each player vs. holding it up or passing it round.

Fig2: The reveal in iPad vs. paper games

Sharing decisions: The final naming/ sound task worked differently in the two media. IPad gave more engagement because players explored the sound options, focusing the group on a joint decision. Implicit decision making was through e.g. laughter, gesture. *Ownership*: The shared focus on a single iPad or paper contributed to shared ownership. IPad drawing was novel and led to fewer worries about 'not being artistic'. Style was less recognizable on the iPad than on paper, potentially allowing more freedom and confidence.

Sharing ideas and experience: F1 did not share during drawing for either medium. However, iPad images gained cohesion because of traces left from previous rounds. F2 shared ideas in both media within games:

again, differences were between groups rather than media. While both paper and digital can provide traces for the next user, the potential for these is greater in the digital, in that software can select what history might be revealed or hidden from the next user.

Our chosen task conceals work until the reveal and such ahistorical structures are used e.g. for brainstorming tasks to generate 'uncontaminated' ideas. The shifting between private and public allows individual ideas as well as shared products and experience. Both paper and digital produced original ideas, e.g. drawing hooves for feet, ladders for legs. Sharing of ideas may have been enhanced in that authorship of contributions was not explicit.

In sum, we found differences between groups rather than media: the different ways people use paper for this task can be mirrored when transferring to a new medium. Using the digital to ensure continuity between drawings suggests that transferring this activity to tablet adds functionality without sacrificing the flexibility afforded by paper. Like paper, the iPad enabled smooth shifting between small group and individual work through shielding, showing and sharing. Tablets have the form factor to support rapid and smooth shifting of attention between individual and group activities and so the potential for effective collaborative learning. Educational apps could therefore productively go beyond the individual or the two-player game mode towards tasks shifting between individual and group work. Many creative tasks – brainstorming or product design -- might benefit from flips between private and shared to yield serendipitous combinations of ideas.

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