BRAINSTORMING AT A TABLETOP

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MOTIVATION

Brainstorming is an idea generating technique. It encourages "out of the box" thinking and helps produce a set of fresh ideas. Brainstorming has two parts: an idea **generation (storming) phase** and an idea **categorisation (norming) phase**.

The storming phase relies on:

1. Criticism not permitted (judgment of ideas is left till later)
2. Unusual ideas are welcomed (the wilder the idea, the better: it is easier to tone down than to tone up)
3. Quantity is encouraged (more ideas, increases likelihood of useful ideas)
4. Combination and improvement are sought (aim to build on other people's ideas, as this leads to more ideas).

In the norming phase, ideas are discussed and evaluated. Ideas are merged, grouped and categorised. Duplicates and rejected ideas are removed.

A tabletop interface has the potential to support brainstorming in new ways.

CHALLENGES

Key problems for brainstorming are:

1. Free riding (when an individual believes their contribution is unimportant or that they just do not participate fully)
2. Evaluation apprehension (the fear of negative evaluations from other group members)
3. Production Blocking (by not releasing an idea, it is likely to be forgotten or suppressed).

DESIGN GOALS

Using the constraints and opportunities imposed by tabletop interaction, we aimed to improve the brainstorming process compared to conventional methods, such as a whiteboard or paper, whilst retaining face- to-face collaboration. We conducted a comprehensive interface review to establish a set of design goals, we used these to create a system and evaluated against them. Refer to the table in the upper right and the figures on the right-most column (Figures 4 and 5).

Design Goal	Achieved	Reflections
Support fast, concurrent idea generation	✓	Idea generation mainly worked well. Consider making tabletop non-interactive in storming phase to ensure adherence to recommended practice.
Many ideas visible on the tabletop at once	partly	Mainly achieved visibly of ideas. For storming display with many ideas, refine presentation of better visibility. In norming, refine lasso to improve visibility.
Don't enforce orientations or territories	✓	Retain central location of ideas generated as it works well.
Foster awareness of ideas as they are generated	✓	Awareness during storming was well supported and newest ideas highly visible.
Make clear the creator of each idea	✓	Relative contributions were clear. Improve aesthetics.
Support flexible grouping for idea convergence	✓	Grouping worked well, including subgroups. Refine lasso to support reorientation of groups of ideas and add undo.
Capture the group's process and final outcome	✓	Currently not available to participants. Add interface elements for reflection phase and re-conceptualisation.

EVALUATION

We evaluated the system in a qualitative user study with 24 users in six groups. We compared against a control condition based on a whiteboard.

We found the tabletop facilitated awareness and participants preferred typing to writing ideas and the tabletop generated more ideas relative to the whiteboard. Refer to Figure 1.

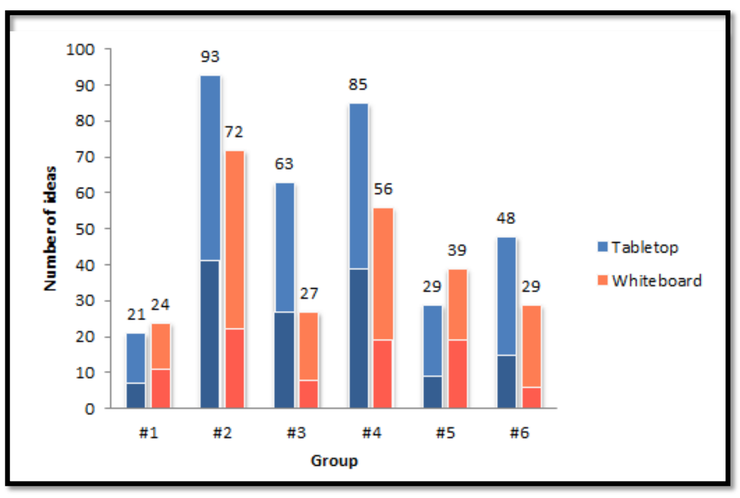

Fig 1. Number of ideas generated at the end of the storming phase. Shown with a white line in the middle, is the session at 5 minutes. Total ideas are shown above the columns.

We found the rate of production to be substantially higher on the tabletop relative to that of the whiteboard counterpart. Refer to Figure 2.

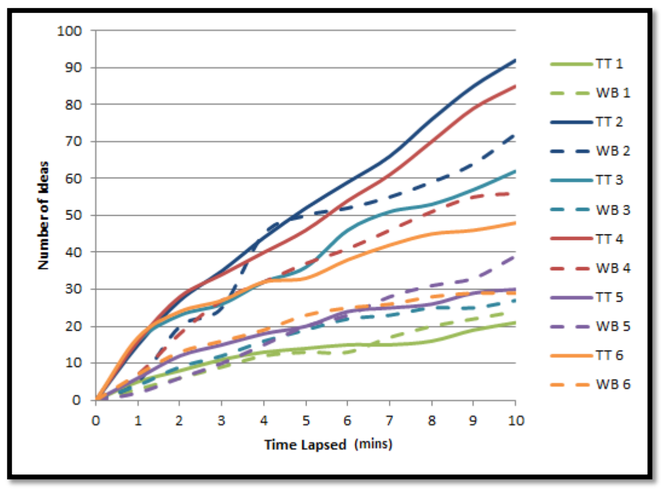

Fig 2. The number of ideas generated in the storming phase with each condition.

Grouping was simple on the tabletop, with features such as the lasso. Refer to Figure 3.

Fig 3. (Right) A user dragging a 'lasso' over a group of notes and then moving their finger to a container; (left) the notes are moved into the container when the user holds their finger still.

We found that orientation and coding facilitated awareness during the storming phase. Refer to Figure 4.

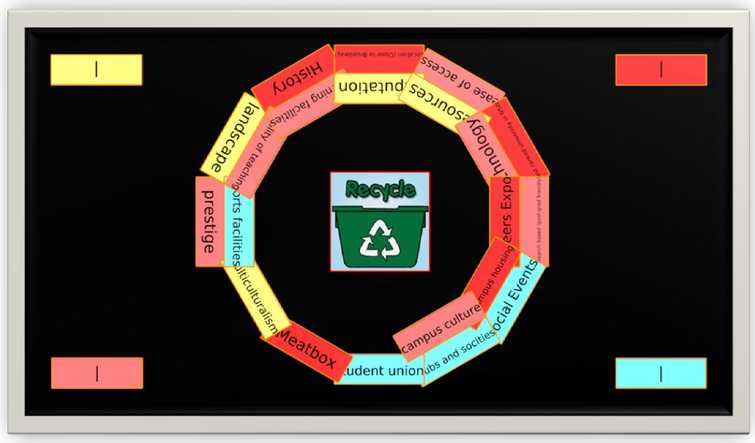

Fig 4. Group 1 at the end of the storming phase. Notes are shown in a spiral in the middle of the table; the notes in the corners are linked to the physical keyboards.

We found that groups made reasonable choices of categories and mostly did well placing appropriate ideas in these. Refer to Figure 5.

Fig 5. Group 3 at the end of the norming phase. Containers are made by flipping a note; in the figure there are six containers/categories, each with a title.

CONTRIBUTIONS

- **Constraining tabletop interaction helps overcome problems** in brainstorming, such as free riding and production blocking.
- The **potential of a tabletop to capture useful aspects of the process by logging.**
- **Support learning about effective group interaction**, for example aiding a teacher understand what their students were doing.
- A **better understanding of the effect of design choices on group brainstorming** at a tabletop interface.

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