Open Learner Models to Support Reflection on Brainstorming at Interactive Tabletops

Andrew Clayphan, Roberto Martinez-Maldonado, and Judy Kay

School of Information Technologies, The University of Sydney, NSW, 2006, Australia
{andrew.clayphan,judy.kay}@sydney.edu.au
roberto@it.usyd.edu.au

Abstract. Brainstorming is a widely-used group technique to enhance creativity. Interactive tabletops have the potential to support brainstorming and, by exploiting learners' trace data, they can provide Open Learner Models (OLMs) to support reflection on a brainstorming session. We describe our design of such OLMs to enable an individual to answer core questions: C1) how much did I contribute? C2) at what times was the group or an individual stuck? and C3) where did group members seem to 'spark' off each other? We conducted 24 brainstorming sessions and analysed them to create brainstorming models underlying the OLMs. Results indicate the OLM's were effective. Our contributions are: i) the first OLMs supporting reflection on brainstorming; ii) models of brainstorming that underlie the OLMs; and iii) a user study demonstrating that learners can use the OLMs to answer core reflection questions.

Keywords: Open Learner Models, Brainstorming, Reflection

1 Introduction and Related Work

Brainstorming is a technique to help produce creative solutions to a problem [5]. It starts with an idea generation phase, *storming*, followed by assessing and grouping the ideas. To be effective, core rules should be followed to reduce members social inhibitions and stimulate idea generation: the focus should be on the *quantity* of ideas; everyone should contribute; there should be *no early evaluation*; particularly *no criticism*; and *un-usual or divergent ideas are welcomed*. All should contribute fully and equally, with discussion limited to cases where people are *stuck* and cannot create ideas.

Multi-touch interactive tabletops can support free flow of ideas by providing a shared group interface so that people can generate many ideas in parallel [4]. A less explored potential of interactive tabletops is to show key information about group and individual performance as Open Learner Models (OLMs) [2]. OLMs can serve several roles, including support for reflection [3], formative assessment, and to facilitate collaborative interaction. It has been shown that there is value in providing multiple OLM representations to support higher levels of reflection, because different learners prefer different forms of OLMs, particularly to meet differing concerns [6]. Research has explored OLM visualisations at interactive tabletops in research settings and in classrooms for teacher use [1, 7].

2 Open Learner Model Design

To enable learners to answer our core questions, we designed the OLMs in Figure 1. *Item 1*: number of ideas each person created (C1). *Item 2*: each idea is a dot, its colour indicating authorship, vertical axis shows its final category, coloured rectangles show when the group was stuck (2a) and coloured bars for individuals (2b), yellow bars show where one person's idea followed closely after another's and both went into the same category (2c) (C2,3). *Item 3*: ideas created by each learner, every 30 seconds (C1,2). *Item 4*: cumulative count of ideas generated (C2). *Item 5*: indicators of group members talking. We expect discussion when a group is stuck (C2,3). *Item 6*: all ideas in their final categories, author, and creation time.

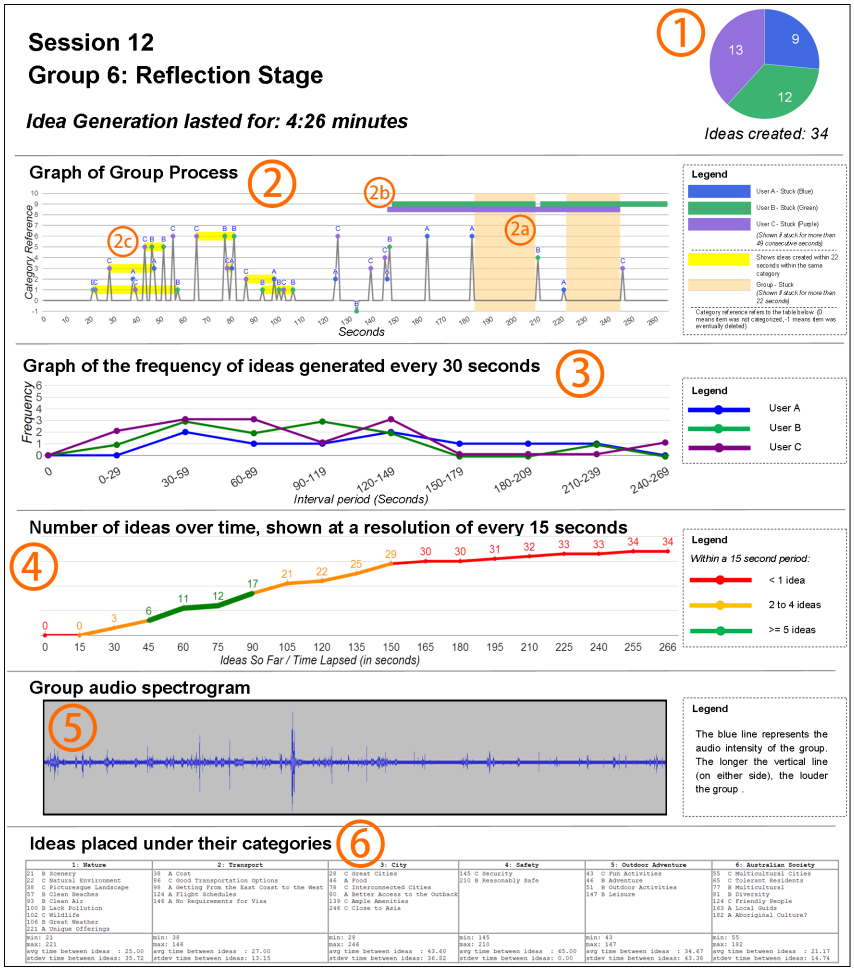

Fig. 1. OLM visualisations.

3 Evaluation and Results

An interview/think-aloud study was conducted with 15 participants. OLMs were presented on large laminated sheets. Participants answered a series of questions on a 6-point Likert scale (6 for strongly agree). Q1: I could work out how much was my contribution; Q2: I could figure out when we made the most ideas in the session; Q3: I could see who created each idea; Q4: I could see when the group was talking; Q5: I could figure out when the group got stuck; Q6: I could figure out when I got stuck in the session; Q7: I could figure out the times when the group created a burst of ideas that ended out in the same category; Q8: I could figure out periods when the group was on a roll; Q9: I could see how the ideas were categorised; Q10: I thought the group did a good job in the brainstorm; and Q11: I thought I did a good job in the brainstorm.

Participants answered these questions by studying OLMs from 3 anonymised brainstorming sessions, as follows: 1) Pretend to be the learner who produced 13 ideas in a group that made 34; 2) Study the OLM from a high performing group (created 80 ideas), reviewing earlier answers; 3) Pretend to be a learner with 52 ideas in a group with 98; and 4) Open-ended questions about including the OLM for reflection.

Learners strongly agreed that the OLM visualisations provided key information about the group brainstorm ($\geq$4.20 across the Likert scores). As participants worked, over half commented on good understandability, especially by the third group OLMs.

		Contributions				Stuck		Sparking			Others impact	
Questions		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Step 1 34 idea group	Likert	5.07	5.53	4.87	5.40	5.67	5.87	4.20	5.00	5.20	4.40	4.73
	Item	1,3	4,3	2,6	5,2	2,4	2,3	2,6	4,2	6,2	1,2	3, 2
Step 2	Likert										**3.40**	**4.40**
Step 3 98 idea group	Likert	5.53	4.93	5.33	5.20	5.27	5.40	**5.20**	5.20	5.27	5.20	5.60
	Item	1,6	4,2	6,2	5	2,4	2,3	2,6	4,3	6,2	1,4	1, 3

Table 1. Summary of responses. Item number is as in Figure 1. Item rows shows most commonly used items for each question. Bold shows statistically significant change from Step 1 to 2 (Q10,11), and from Step 1 to 3 (Q1-9).

4 Discussion and Conclusions

C1: who contributed?: Participants initially judged equality by referring to Items 1 and 3. After seeing additional OLMs, participants switched focus to numbers of ideas produced. For Q1, participants use Items 1, 3 & 6. for Q2, 12 people used Item 4 − number of ideas over time, checking the colour scheme. A small number used Item 3, identifying when most ideas were generated was high by all members. For Q3, Items 2 and 6 were used.

C2: when was the group or individuals stuck?: For Q5 and Q6 participants used Items 2, 3 & 4, with Item 2's timeline, shaded regions and horizontal bars proving the most useful to identify stuck periods. These indicators (the shading,

bars and coloured segments) can be the basis for group discussion and reflection about what caused the group to be unproductive.

C3: where group members 'sparked' off of each other?: For Q7, Item 2 was used, but with a mixed response. 8 participants said the yellow highlight in Item 2 was obvious, but 4 other participants found it unclear or did not notice it, instead scanning across the grey line of each row. 3 participants mentioned Item 6. To determine when a large number of ideas were created, regardless of category, most participants shifted to Item 4. Overall, Item 2 was the most used.

Impact of OLMs from different groups: On seeing the high performing group, participants altered their assessment of how well they and the their group had performed. For Q10, 8 participants downgraded their responses leading to a statistically significant difference, and for Q11, 5 participants downgraded their responses.

In summary, we designed a set of OLM visualisations to help individuals reflect on group and individual performance and processes for group brainstorming. Our study indicates learners found the OLMs generally easy to understand and could answer our questions. The study enabled us to learn how people use the visualisations to answer each of our questions. This is a foundation for creating an enhanced form of tabletop brainstorming system, which can help people reflect on a session using our OLMs to answer the series of questions that will enable each group member to assess the level of their own contribution, the times the group was stuck and whether they sparked off each other.

References

1. Al-Qaraghuli, A., Zaman, H., Olivier, P., Kharrufa, A., Ahmad, A.: Analysing tabletop based computer supported collaborative learning data through visualization. Visual Informatics: Sustaining Research and Innovations pp. 329–340 (2011)
2. Bull, S., Kay, J.: Student Models that Invite the Learner In: The {SMILI} Open Learner Modelling Framework. IJAIED, International Journal of Artificial Intelligence 17(2), 89–120 (2007)
3. Bull, S., Kay, J.: Metacognition and Open Learner Models. In: The 3rd Workshop on Meta-Cognition and Self-Regulated Learning in Educational Technologies, at ITS2008 (2008)
4. Clayphan, A., Kay, J., Weinberger, A.: Enhancing brainstorming through scripting at a tabletop. In: Educational Interfaces, Software, and Technology 2012: 3rd Workshop on UI Technologies and Educational Pedagogy (2012)
5. Isaksen, S.: A review of brainstorming research: Six critical issues for inquiry. Creative Research Unit, Creative Problem Solving Group-Buffalo (1998)
6. Mabbott, A., Bull, S.: Alternative views on knowledge: presentation of open learner models. In: Intelligent Tutoring Systems. pp. 131–150. Springer (2004)
7. Martinez Maldonado, R., Kay, J., Yacef, K., Schwendimann, B.: An Interactive Teacher's Dashboard for Monitoring Groups in a Multi-tabletop Learning Environment. In: Intelligent Tutoring Systems. pp. 482–492. Springer (2012)