

The Impact of Interactive Tables and Multiple Surfaces Technologies Towards Communication and Learning

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ABSTRACT

Multi-touch interactive tables are vast becoming ‘must-have’ items for enhancing the collaborative learning experience. There is extensive amount of literature promoting and highlighting the impact of collaborative learning around interactive tables towards learning, communication and social interaction. In this paper we present several of our existing work investigating the communication impact that emerges during collaborative peer learning activities around tabletop. It is also worth noting that we present findings of collaborative outcomes from two countries. Finally we highlight our interests and ideas that we hope will be addressed and discussed during the workshop in the light of shaping the future of multi-touch multiple surfaces for learning.

Categories and Subject Descriptors

H5.3 Group and Organisation Interfaces.

General Terms

Human Factors.

Keywords

Interaction techniques, tabletop, communication, collaborative learning, multiple surfaces and India.

1. INTRODUCTION

Over the last years, multi-touch interactive tables have since become a sought after educational technology motivated by the declining cost of projection technology, easily accessible on-the-shelf materials (such as infrareds LEDs and camera) and the growing number of open source applications. Not only that interactive table offers participants simultaneous contribution, it also provides a natural platform for face-to-face collaboration-visual cues such as body language, facial expression as well as body movements and interactions are highly visible. Research shows that interactive tables are valuable for mediating conflict [18], support decision making [13], promote communication [9] and learning [2, 7]. The applications of interactive table are especially promising for collaborative learning experience due to the attractive benefits of equitable and simultaneous participation. Although multi-touch tabletops are common apparatus for the ‘classroom of the future’ vision [1, 8, 12], their impact on communication during collaboration remains unclear.

Relatively, few studies have addressed the impact on communication and collaboration when a group of children work together around interactive tables during learning activities. Moreover, studies that investigates collaborative peer learning task that is based upon real-world classroom activities is fewer still. Peer collaboration in children’s learning is becoming an increasing aspects of children’s educational experience [20]. Parallel with the national curriculum guidelines, teachers are now including more group activities during lessons to foster social,

emotional and communication skills [5]. The aim of group activities is to allow children to jointly explore particular areas by discussing and exchanging ideas, thereby facilitating their understanding. Key to the success of these peer collaborations from a learning perspective is the extent to which children participate in the collaboration [15]. In particular, it is the extent to which children communicate with each other that is the essence of successful learning [19].

According to Stahl [17], group discussion facilitated through the usage of applications and technology can lead to “shared understandings, new meanings and collaborative learning”. Not only that group work provides the platform for meaningful learning but also the opportunity for social interaction to take place. Communication that is generated through this method of discourse also promotes “inter-subjective knowledge” creating deeper understanding and reflection on the topic.

With the characteristics of successful peer in mind, interactive tabletops have the unique advantage of supporting face-to-face collaborative learning. According to Rogers and Lindley [14], participants in the multi-touch tabletops tend to explore more ideas together, and higher awareness and visibility of actions performed by each other and frequently switched roles between members. Moreover, interactive tables are pleasurable and engaging to use [3, 11] and at the same time found to promote equity of participation [4] and encourage learning [7-8, 10, 16].

A clear motivation is present in highlighting the need to investigate the communication patterns and interactions that exist during collaboration around interactive table in order to support and enhance the shared learning experience. To fill in this knowledge of gap, this paper presents a series of on-going research studies exploring the communication patterns and behaviours (both verbal and non-verbal) that arises during collaborative peer learning activities between children around multi-touch interactive tables. It is our intention that we address the following questions:

- What type of talk patterns is visible during collaboration around interactive tables?
- What form of non-verbal, gestures and bodily actions are present during collaboration around interactive tables?
- What type of object interaction techniques can we expect during peer collaboration?
- How do interactive tables promote social interaction between participants?
- Deploying the tabletops outside of the UK, what type of behavior and interaction can we observe?

- How do interactive tables promote social interaction between participants
- What type of impact on communication does interactive table have- do they promote or discourage collaboration?

We present a short summary of four studies of 11-13 years old students performing collaborative learning activities around interactive tables to investigate this issue further.

2. STUDY ONE

This work presents the findings of a study that observed the conversation styles of children working on interactive and non-digital tables [6]. We looked at five types of utterances: identification, proposals, responses, interdependence and instructions. More specifically, this paper presents a study that investigates the conversation styles of children around interactive and non-interactive tables and seeks to examine the following points: 1) what type of conversation styles exist around these tables? 2) what are the different trends for proposal and response utterances? 3) do the participants identify themselves as individuals or as a group? 4) how are interdependence and instructions demonstrated? 5) what would be the topics of discussion? To answer these questions, we performed a study that involved 39 children who worked in teams to produce a spider diagram. We worked with teachers and staff members from local schools when designing and developing the application to ensure that it appropriately reflects classroom activities. We recorded and analysed approximately 120 minutes of video of the participants completing the task. Our findings address the questions identified above by presenting the different conversation styles between the two tables. The results also describe the following factors: individual versus group identification, the various trends of proposals issued and responses received, and the forms of interdependence and instruction present around the two tables.

Children working on the interactive and non-interactive tables exhibited different conversation styles. Overall, children working on the interactive table talked longer and produced more utterances. This allows more time for latecomers to contribute their ideas and to be part of the decision-making process. The participants perceived themselves more as individuals, leading to command-like utterances that show their dominant role during the task. However, the authoritative behaviour is likely due to the transition between single and multi-touch interaction when drawing lines between elements. The non-interactive table on the other hand, promotes a different conversation style. This style is more intense during the first four minutes of the task. The number of responses is higher when working around the non-interactive table, suggesting more participation, collaboration and decision making processes. Participants on the non-interactive table are more focused towards task-related issues as they do not need to consider specialised methods for manipulating objects (e.g. drawing line can be done simultaneously using pens).

Based on our observations and the fact that the task, objectives, actions and methods on both tables are similar, we believe that the differences in the conversations generated are due to the methods of interaction between the two tables.

3. STUDY TWO

Our previous study indicated that the difference in talk pattern could potentially be caused by interaction technique. In Study Two, we further refine our tasks, techniques and topics to investigate this issue further. Central to this interest are arguments relating to demonstrated benefits of peer collaboration in children's learning

that have led to such activities becoming an increasing aspect of children's educational experience [24]. The aim of such experiences is to allow children to jointly explore particular areas, discussing and exchanging ideas and perspective and thereby facilitating their understanding. Key to the success of these peer collaborations from a learning perspective is the extent to which children participate in the collaboration [18]. In particular it is the extent to which peers talk and the nature of this talk that comprises this participation that is argued to be key to successful learning [22]. For example, successful collaborative learning has been demonstrated to happen when accompanying talk of this equitable participation consists of greater explanations [23], clarifications [5, 12]; and more shared discussion of goals and plans [16].

Given these characteristics of successful peer collaboration in learning, interactive tabletops are argued to have a number of properties that lend themselves to supporting such collaboration in computer mediated learning environments for several reasons [10] such as tabletops promote particular proxemic arrangement of groups around the shared learning material supporting face-to-face interaction. Building on these findings, and the arguments that particular types of talk within peer based collaborative learning are important [22], our concerns in this paper are with the impact of particular tabletop interaction techniques on the type of talk during collaborative learning. Surprisingly there is little in the way of empirical research that specifically examines the effects of the tabletop interaction techniques seen in Nacenta et al. [15], on patterns of conversation in collaborative learning scenarios. In a different study, Harris et al. look at single vs multi touch for this scenario but do not explore different interaction techniques within this context [10].

In Study Two, we present the findings of a user study investigating conversational patterns across three conditions of table-based interaction (direct touch interactive table, pantograph interactive table and non-digital table) for different types of educational activities [7]. We recruited 28 pupils from local secondary schools (14 males and 14 females), aged between 11 and 13 years old. The participants were divided into seven groups of four pupils, which is typical of group-based classroom activities in the UK, suitable for four-sided tabletop conditions and fulfils the criteria for working in "small" groups [6]. Findings demonstrate that communication style is significantly affected by interaction techniques. The direct touch technique stimulated conversations based around the topic and pedagogical method. The pantograph technique promoted playfulness and had a higher number of directive utterances between participants, with fewer task-based, group-oriented utterances. The non-digital table promoted reflective forms of task-orientated utterance, encouraged group communication and fostered more equitable participation between members. We also found that direct touch is as good as the non-digital table with respect to interdependence and reflective form of topic-based conversation. Such features are desirable for collaborative peer learning tasks. Meanwhile, the pantograph technique encourages playfulness and directives but is not very good at promoting interdependence, topic-orientated and reflective form of conversation in support of small group communication for classroom-based activities.

The choice of interaction techniques when deploying ecologically appropriate tasks in a real world settings matters. One converging observation from several in-the-wild studies of digital tabletops and other public use displays is that interaction techniques must be simpler than those used on person displays, as people typically

do not get the chance to practice these techniques when they are in a “social safe” environment (e.g. when they are alone or practice time prior to using the technique in public). Thus participants tend to get more caution as to not face public or social embarrassment. The reported incidents of students directing others to implement actions on their behalf in the pantograph conditions is in-line with this finding.

4. STUDY THREE

Our third study explores the communication behaviours of children outside the United Kingdom. We seek to investigate children’s behavior in another country, given the same technology, similar interaction techniques and tasks what type of communication and interaction behaviours that emerge? This finding is crucial in understanding the impact of the widespread deployment of interactive technology beyond the Western world.

We explore how children in a local female-based school in Delhi, India interact with digital objects on interactive tables. In particular we are interested in observing the behaviors and object interaction strategies exhibited by the children in their collaborations. First, we saw that the children frequently move the same object together i.e. two, three or more children touching, manipulating and moving an object simultaneously. Second, we saw the children grouping together around one location at the tabletop and working very closely to each other within that small space. What is notable is that they appeared, through their interactions and language, comfortable working within close such proximity of one another. Third, the usage of multi-finger input beyond the standard index finger for touching and manipulating objects is commonly seen. The children frequently used their middle, index and little fingers when interacting with digital objects, rather than just their index fingers, as is more commonly seen in Western contexts. Interaction designers should be sensitive to the diverse interaction and collaboration strategies employed by the children in developing countries as well as those seen in the West, particularly as these emerging markets are now beginning to explore the potential of new technologies.

5. STUDY FOUR

We explore how children in two local schools (mixed gender pupils) in Delhi, India use their gestures and bodily actions as part of their communication and interaction during collaboration around multi-touch interactive tables. We observed two main findings. First, we saw that the children dynamically position themselves- moving from one location to another around the table throughout the tasks. Second, we found the children using above-the-table hand actions and gestures in concert with their conversation. Both findings indicate expressive and dynamic type of collaboration strategies- a new insight for designers of tabletop applications.

6. CONTRIBUTIONS

The work presented in this paper offers the following contributions to the areas of interactive tables, communication and learning:

- A systematic analysis the different types of effect of three tabletop configurations on the students’ interaction and conversation during a collaborative learning activities [7].
- A set of coding scheme based on literature surrounding learning, communication and interactive tables that

serve as a guideline for researchers investigating talk analysis on collaborative peer learning activities [7].

- Studies of tabletop configurations in real-world settings with ecologically appropriate tasks that were created in collaboration of students, teachers and staff from local schools provide insights into the direct implementation and deploying of this technology within a classroom and learning environment [7].
- The social and digital object interaction behavior of students outside of the United Kingdom when the interactive tables were deployed in two schools in Delhi, India
- The usage of multi-finger, beyond the typical thumb-index finger combination when interacting with digital objects on the tabletop
- The findings of peculiar group behavior when children in India interact with digital objects- they tend to move the same object together as well as were often found to be working within close proximity of each other.
- Dynamic spatial positioning- children in India frequently move around the tabletop whilst collaborating to complete the task
- Embodied organization and control- above the table bodily actions and gestures used by children to expressively communicate their intentions and actions as well as to coordinate and organise themselves.

7. DISCUSSION FOR THE WORKSHOP

For the workshop, it is of our intention that the discussion during this event will promote the following interests and ideas in the light that it will not only contribute towards my study but also the community of designers and researches in general:

- With the lower materials and projection costs, it is possible that the deployment of interactive tables in classrooms in the future can be increasingly seen in countries such as India, China, Finland, Malaysia and others. Given the same facilities of interactive table such as interaction techniques, tasks and applications; how can we support cross-countries learning without interfering with the natural learning styles of the students? Do we provide opportunity to personalise the applications and techniques or can we utilise general forms of applications and interaction methods, such as Microsoft Word? How can we celebrate the ‘uniqueness’ of learning and collaboration styles that each country has to offer without compromising on positive communication and learning?
- Looking into the potential of multiple surfaces for collaborative learning how easily is the transition of information and content between surfaces both in terms of interaction technique and social interaction? It is possible that different surfaces promote certain kinds of behaviours, hence by mixing those surfaces together (e.g. iPads, mobile phones, interactive table and whiteboard) will it support positive communication and learning outcomes or will it disempowered collaboration lead to confusion and frustration?
- Extending the scope of multiple surfaces into the world of multiple technology, how can we design a smooth

interaction and application that flows smoothly as if there were 'one' i.e. learning, collaboration and communication flows without interruption between the technologies and that those combined technologies only serve to enhance those experience? For example, integrating interactive tables with kinect based technology for direct and gestural input when exploring about fluid dynamics of an airplane? Also using mobile devices such as iPads and combining it with brain computer interfaces during field trip to enhance engagement and collaboration?

- Finally we would like to see the direction and possibility of implementing multiple surface learning experiences into local schools, colleges or universities in the first part of 2012.

We look forward to the stimulating and inspiring discussion during the workshop.

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