MOBITOP: INTERACTIONS EMPLOYED BY USERS WHEN USING A COLLOCATED AD-HOC COLLABORATION APPLICATION

Ong Beng Liang[1], Teo Rhun Ming[1], Noris Mohd Norowi[1], Evi Indriasari Mansor [2], Prasenjit Dey[3]
and Izdihar Jamil[4]

[1]Department of Multimedia, Faculty of Computer Science & IT, Universiti Putra Malaysia, Serdang, Malaysia
[2]Department of Information Systems, College of Computer & Information Sciences, Prince Sultan University, Riyadh, Kingdom of Saudi Arabia
[3]IBM Research, Bangalore, India
[4]APITECO, Selangor, Malaysia
E-Mail: ongbengliang@gmail.com

ABSTRACT

This paper presents a Collocated Ad-hoc Collaboration (CAC) application -- the MobiTop system which is a multi-mobile system that allows users to come together with their mobile devices in an ad-hoc manner, and integrates together as one seamless display surface with multi-touch capabilities. It has transformed the society into a more hands-on environment with the innovation of this system. Our findings show that users tend to settle and compromise when working collaboratively, for instance setting with an inverted orientation of the screen rather than dynamically positioning themselves around the MobiTop system. Consequently, users tend to draw an 'upside-down' object orientated towards other users rather than towards themselves. Several reasons contributed towards this form of interaction are such as the complexity of the objects, the bezel on the tablet and group-like behavior. With this understanding, we believe that MobiTop system can provide the next step in the evolution of collaboration beyond the expensive tabletops systems for the society.

Keywords: mobile devices, collaboration, multi-touch digital tabletop, collocated ad-hoc collaboration.

INTRODUCTION

Communication is a process whereby information is exchanged between people and a part of humans' social life. During the olden days, our ancestors used smoke signals as a medium of communication which could only send limited simple messages. Smoke signals were then replaced with letter writing until the creation of telegraphs in the 19th century. The invention of telegraphs has brought about generational changes in communication [1]. Due to the advancement of technology, society nowadays is experiencing a fast moving transformation with borderless communication at their fingertips using various forms of technology such as mobile devices and smart watches (e.g. Apple Watch).

Mobile devices are increasingly becoming an important part of technology in our daily lives. These devices have become more than just receiving and making phone calls and text messages. The introduction of multi-functional mobile devices such as smart phones and tablets, have allowed us to be mobile and dynamic in managing our daily activities such as online shopping, bill payment, managing business tasks (answering emails, conference calls etc), sharing images and videos of our lives with our families and friends, connecting us to social media and many others. The advancement of technology also contributed to decreasing the cost of owning the mobile devices, thus making it affordable for the mass market. It is obvious that the usage and need of mobile phones are crucial in handling various forms of information to cater for both our daily and social activities.

As the demand for handling information grows, so does the need for collaboration in handling multiple forms of information, whether it is between colleagues at work, families at home and students at schools. In-situ *collocated* (located at the same place and time) *collaboration* is necessary as groups of people come together to exchange and share information with each other, brainstorm a particular idea, discuss and update particular tasks, plan, play games or even to give feedbacks to a design project. Mobile devices (such as mobile phones and tablets) has had a huge technological advancement in our daily and social activities, for example, writing a business email while waiting for the train, using an App to pay bills, shopping online, updating personal status on social media and many others. However, mobile devices are generally built to cater for personal informational needs. With its small screen, it is relatively uncomfortable for two or more people to share information and perform tasks collaboratively.

A technology that has a large horizontal surface and one that is commonly linked with in-situ *collocated collaboration* is the multi-touch digital tabletop [7]. It allows a small group of people to comfortably collaborate together in a simultaneous fashion which is more than one person can contribute directly towards the discussion being located at the same place and time [21]. Moreover, its large horizontal surface allows for a productive face-to-face discussion in solving the given tasks such as planning, design and organization [8]. However, the two main downsides of this technology are that: (a) it has a high price tag which means it is not easily accessible and affordable to the mass market; and (b) its large size and

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heavy weight means that it is not mobile. Users need to go to the digital tabletop's location in order to use such devices making it unusable for impromptu and on-the-go collaboration. For an impromptu collocated collaboration, mobile devices offer the mobility, size and affordability cater for such collaboration. Several works such as the studies by Lucero et al. [14,15] and Hinckley [9] demonstrated that extended mobile devices system offer an exciting, enhanced and beneficial working experience.

Our work builds on existing system (e.g. by Lucero et al. [14, 15]) where we look at three more additional important aspects using the MobiTop system: (a) User study of Collocated Ad-Hoc Collaborations (CAC) applications as opposed to Collocated Ad-Hoc Sharing (CAS); (b) User interactions employed by users for such ad-hoc mobile collaborative applications; (c) Interactive Drawing Application (IDA) where users can express their ideas directly onto the touch-based display. We designed the MobiTop system (a system that is similar to the work by Jokela & Lucéro [12] that allows users to connect their mobile devices impromptu) to explore these issues further. The MobiTop system uses off the shelves mobile devices that can be connected in a grid pattern of two, four, six, eight and ten mobile devices. For the purpose of this study, we use a grid of four mobile devices in a single connection.

We present the MobiTop system - a multi-mobile system that allows users to come together at any location and perform collaborative tasks and information sharing by extending their mobile devices. The MobiTop system has the mobility and affordability of the mobile devices, the capabilities of multi-touch digital tabletops (where groups of users can simultaneously contribute towards the discussion) as well as an extended surface of collaboration (compared when using a single mobile device). The implication of this system can potentially enhance social interaction between users as they are able to share their ideas and collaborate together on a project in an impromptu manner. In other words, the users can directly and intuitively manipulate and collaborate across this integrated display surface in tasks such as planning, designing, and editing. When users complete their collaboration and leave (the devices sense proximity), the latest snapshot of the collaboration automatically gets saved into individual devices. The users can then choose to work on it at a later point of time or use it for other tasks. Groups of people who own mobile devices can collaborate together dynamically regardless of their location with the affordance of a large horizontal shared display surface.

With the above facilities, it can potentially promote a beneficial and interactive collaboration when groups of social users such as co-workers, students, families and friends come together to brainstorm their ideas. The simultaneous input contribution allows users to participate and present their ideas in the moment without having to engage in a turn-taking manner, which by then users could potentially lose track of ideas. Users can also work with each other in an ad-hoc manner, for example, a group of co-workers working together collaboratively on their design while having lunch at a local café. They simply connect their mobile devices using the MobiTop system and collaboratively brainstorm their ideas by benefiting from the extended screen size. Moreover, little work in the literature investigates how users from such part of the world collaborate around multi-touch systems.

RELATED WORKS

Sharing information collaboratively in an impromptu manner has become an increasingly popular task especially with the recent advancement of technology. Deutsch [5] proposes that collaborative activities are geared up when the goals of each member in a group are so linked up that there is a positive correlation in attaining those goals together. As members in a collaborative environment encourage each other to engage and participate with the task, members are likely to contribute towards the discussion which will result in a successful experience [5]. Following this, mobile devices offer several attractive features in supporting collaboration such as mobility, portability and affordability such that it can be easily owned by the mass market. Several studies have looked into various aspects of mobile devices with regards to collaboration such as the work of Rogers et al. [20], Yatani *et al.* [25] and Joseph *et al.* [13] to name a few. Rogers *et al.* [20] investigated how mobile devices can be used to support sense making. Yatani *et al.* [25] used mobile devices to investigate users' behaviours when presented with tactile feedback. Joseph *et al.* [13] demonstrated that mobile devices are an imperative tool during collaboration and vocabulary learning. However, mobile devices and its small display is only comfortable for one to potentially two users to use it at a particular time, thus making small group collaboration consisting of more than two users an uncomfortable experience. Although technology such as the multi-touch digital tabletop (such as the DiamondTouch [4] and the SMART Table^{TM}) offers a large horizontal space to support collaboration and have shown to be beneficial (e.g. in the work of Marshall *et al.* [18] and Jamil *et al.* [10, 11]), its large size and high costs makes it a less appealing choice when it comes to mobility, portability, and affordability. For example, Marshall *et al.* [18] developed a tourist guide application to aid groups of tourists to plan their day collaboratively using the multi-touch digital tabletop. However, due to its large size, users can only use the system at the tourist information centre. Jamil *et al.* [10, 11] presented the talk and behavioral patterns of children using the digital tabletops in multiple countries but had to rebuild the digital tabletops every time due to the lack of portability, thus making it an expensive deployment.

Following this, a number of studies have also looked into using at least two mobile devices to extend the size and space for collaborative work and at the same time taking advantage of the portability and affordability factors of the mobile devices. For example, Fails et al. [6] proposed Mobile Stories where children can use one or

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two mobile devices to create and share stories in the form of content sharing and splitting. Their findings showed that users tend to prefer the content of the application to be split or rather extended to another mobile devices compared to using only one mobile device.

Shen *et al.* [23] demonstrated that the MobiUs system enhances the user experience when viewing video across two mobile devices rather than viewing on a single mobile device. Chen et al. [2] highlighted that using a dual-display system tends to improve the reading experience of the users. These works show that, using more than one mobile device that enhances the display surface is generally desirable for information consumption tasks such as reading and viewing video. However the in-situ collaboration aspects using multiple mobile devices that integrate as one seamless system with multi-touch capabilities are not dealt with in these works.

The study by Lucéro *et al.* [15] explores the use of multiple touch-based mobile devices in a collocated ad-hoc sharing (CAS) application for photographs. It details some interactions techniques to share photographs between groups of users using their personal mobile devices in an ad-hoc setting. The study also shows that people find such ad-hoc sharing sessions useful and exciting. Jokela & Lucéro [12] describe some new interaction techniques and a study of how to form such ad-hoc groups for photo sharing. It was shown that peer based methods, where the whole group feels in control, is generally preferred to a leader based method while forming such ad-hoc groups. However, preferences of the methods also depends on the context (when, where, who) of such sharing sessions occur as well as allowing the users to decide on an interaction methods that best suit their working style.

Tandler *et al.* [24] proposed the ConnectTables where users can come together and combine two mobile devices to support a face-to-face style meeting. The system is equipped with a pen-sensitive tabletop display and a translucent chassis as a container for information technology components. Hinckley et al. [9] builds on the work by Tandler et al. [24] by adding a pen gesture interaction to stitch the mobile devices together. Participants can then share a single photograph by tapping on it or drawing a lasso to select several photographs together. Lucéro et al. [15] proposed an extended mobile devices system where users can connect their mobile devices using several configurations during a mind-mapping brainstorming session. The interaction between participants as well as the interactions between participants and mobile devices created an exciting and beneficial collaborative working space.

Our work builds on the above mentioned work where we look additional aspects in the research area using the MobiTop system. In particular, we look at how users in Malaysia use the Interactive Drawing Application (IDA) to support their brainstorming session during collaboration.

THE MOBITOP SYSTEM

The MobiTop allows two or more users to come together with their mobile devices and hold them in a grid pattern to create one large and continuous collaboration surface. All manipulations on the objects on this surface spans across the devices and the users get a feeling of one single surface. Manipulations such as rotation, scaling and translation happen seamlessly across these multiple screens, and the manipulated environment and its objects are rendered as one single view due to the extended screen size. Different applications were developed to take advantage of the system that promotes collaboration. The MobiTop application is currently implemented as an Android application. Figure-1 shows the start page of the system in a grid pattern.

Figure-1. 4 tablets in a grid pattern displayed the start page of the MobiTop system.

When two or more users come together, they hold their devices in a grid pattern and then launch the MobiTop system on their mobile devices. Then, the devices recognise their proximity and their global coordinate system. One of the tablets becomes the master (host) and other tablets as the slaves (client). In order to create one single integrated display, the master/host device (located at the top-left position) activates Create Group and other slaves/client tablets perform a Join Group. Then, a short video about the MobiTop connectivity setup is displayed on the host's screen which requires a clockwise gesture spanning across these four devices. Once the devices are connected, they work like one single integrated display. The application allows users to interact across this integrated display just like any other multi-touch display surface. The master device maintains the global coordinate system for the integrated display created by the four devices and communicates these coordinates for rendering the object (or part of it) on each of the display.

THE STUDY

The study was designed to investigate the usage of the MobiTop system in a collaborative environment by observing participants collaborate and interact with the Interactive Drawing Application (IDA) on the system. Thirty-two full-time (13 male and 19 female) undergraduates from different courses were voluntarily recruited. Age range of the sample was 19-23 years (mean = 20.8 years and sd = 1.4 years). Participants were

subjected to IDA evaluation tasks for 20 minutes. Eight groups (4 students each) were created based on existing friendship to encourage more intense collaboration. The study was conducted in the laboratory of Faculty of Computer Science at our university. Briefings were given before and after the tasks by two experimenters. Consent was obtained from the sample and a practice session was administrated. 15 minutes were allocated for the evaluation tasks through discussion. Each participant was required to complete a questionnaire. The information requested included the participants' demographic, their current practice of collaborative drawing and review of the MobiTop system. Eight video recordings from the study were analysed. The videos were transcribed and the participants' verbal actions and behaviors were analysed in order to get a good understanding of their collaboration and interaction.

RESULTS

From the evaluation session, a few of interactions employed by the users were observed such as (i) upside-down orientation; and (ii) positioning.

Upside-down orientation

During the IDA sessions, participants tended to draw in a "group-like" orientation. The group-like orientation has a single orientation directed towards a particular direction. One would speculate that each of the four users would use various orientations when drawing their objects considering the extended surface of the MobiTop system. However, our observations show that there seems to be an informal consensus of a single group-like orientation during this activity. Thus, the drawing depicts a single form of orientation even though the users could have easily drawn the object facing his or her orientation. Instead, the object was drawn facing a "group-like" orientation. Figure-2 displays the outcome of the experiment from four tablets depicting the single orientation drawing.

A common challenge with practicing a single, "group-like orientation" was quickly discovered. Some of the participants had to draw the object in the opposite direction of their viewing to fit in with the single orientation. This resulted in the objects being unintentionally drawn upside-down. Figure-3 demonstrates that one participant drew a bird from the original position upside down.
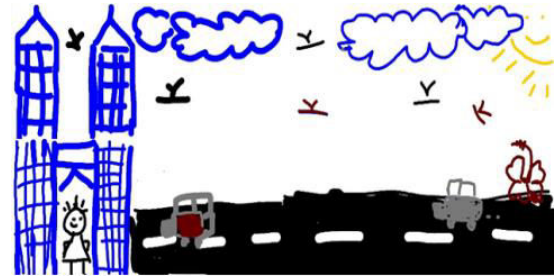

Figure-2. Single, "group-like" orientation.

Based on our observations, there are a number of reasons that lead to the upside-down drawings such as disorientation, level of complexity in the picture drawn, and the force discontinuities in the drawing as a result of the tablets' bezels. Disorientation happened as participants would sometimes become confused when forced to view the structure of the object in an inverted manner, as demonstrated previously in Figure-3. The disorientation amplifies as the participants were required to draw a more complex object. The bezel also contributes to the problem as participants were focused more on tablet that was directly in front of their view.
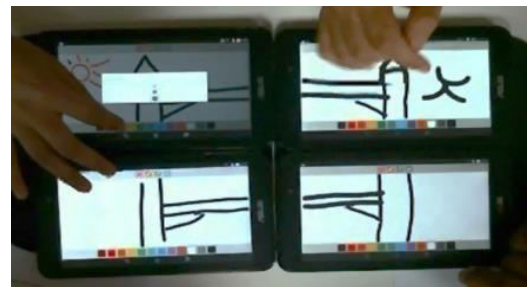

Figure-3. Participants completing the drawing from their position in a "group-like" orientation, resulting in an upside-down bird.

Positioning

With the notion of a group-like orientation present during collaboration especially in the IDA sessions, users could have easily positioned themselves in the direction of the object to make the drawing process easier, i.e. physically relocating themselves towards the direction of their drawing. Rather, they chose to remain static (either standing or sitting down) despite the ample space available in the room to move around, subsequently drawing the objects upside down (Figure-4).

Figure-4. Participants remain in their static position while creating their drawings.

There were occasions where participants are seen to cross from their own tablet to another in order to complete the drawing of the same or a larger object. Participants are also observed to help other members to complete their drawing. However, such interactions were still performed from their original position (Figure-5).

Figure-5. Participants cross over to other quadrant to help other members while remain static at their location.

Based on our observations, one possible reason that can towards the static positioning seen in this experiment is the notion of respecting each other's workspace around the tablets. For example, one of the participants was seen to push away another participant's hand while drawing the cloud. Additionally, some of the participants seemed to think that they need to contribute their ideas in a turn taking manner, that is one person contributing to the surface at one time and need to wait for other's to finish before they can contribute.

DISCUSSION

Orientation

Orientation has long been an issue surrounding multi-touch systems such as mobile devices and digital tabletops. Kruger et al. [17] highlights that orientation plays a key role in assisting users with the comprehension, communication and coordination during collaboration. In general, users would rotate an object such that particular object is facing them to indicate an interest with that object. An interest could mean that the user wants to work on that object, read it or direct it to the attention of other users so that they could discuss about it. For example, in a side-by-side configuration, user A would rotate the orientation of an object in the direction of both user A and B as a form of easing communication and comprehension between both users.

During the task, users were seen to draw objects in an upside-down orientation. This makes comprehension and coordination slightly difficult for the active users (the user that is currently drawing the object) but potentially easier for the receiving users. It is possible that with such interactions, the active user is intending to have an easier form of communication between them and the receiving users to facilitate the discussion during collaboration. That is to say that by orientating objects in the direction of the other users, the active user may be seeking approval of their ideas. When an object is in proper orientation, users can continue with their ideas and discussion with less hindrance.

Additionally, the system setup of the MobiTop system may have contributed towards the upside-down orientation. The mobile devices need to remain in static configuration once it has been setup. Abrupt movement, such as rotating one of the mobile devices upside down could disrupt the connectivity of the system. Hence, in order to present their ideas, it was probably easier for the users to draw their objects upside-down facing the other members rather than rotating one of the mobile devices into their direction and then rotating it back towards its original orientation after the drawing.

Orientation can indicate the separation or intention of spaces such as the establishment of personal and group spaces [17]. This is in line with the work by Scott et al. [22] that there are several forms territoriality in a workspace- personal, group, and storage. Personal territory is the area that is closest to the users and is often viewed as a private area where users would do their work individually. The group space is often located in the middle of the workspace indicating a public space where users can share and view each other's ideas. In the storage space, users often treat it as a 'holding' area for their unwanted, unused, or non-important objects.

Our findings show that users tend to use the extended screen size to demonstrate their ideas. Additionally, the orientations of objects are often in a singular direction indicating a single establishment of space. Based on the single orientation of objects (which could be upside-down for some users), a possible reason for this interaction could be due to the limited screen size, denying users of any personal spaces or activities.

Positioning

Users in general physically locate themselves in the correct orientation of a drawing during collaboration. For example, children in India dynamically and fluidly positioned themselves around the multi-touch digital tabletops when creating a spider diagram [11]. The children would physically move themselves to different locations around the digital tabletop in order to create their drawings or assisting other members. The fluid movement aided the children's collaboration in solving the task. We

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note that there could be differences in behaviors between children and adults, yet spatial positioning is shown to facilitate the learning experience.

During the evaluation tasks, users using MobiTop system could have performed similar physical re-location movements as a solution to their upside-down drawing problem. There was ample space to move around. There was no 'tagging' or personal territory associated with each user. No specific instructions were given to them to remain seated or static at their initial position. Yet they remained static at their position and continued to draw objects upside-down from their orientation. It is possible that the users in the experiment viewed relocating themselves or moving the tablet as an inconvenience to other users, explaining the static positioning. Interestingly, it was observed that during the experiment, a user had attempted to slightly shift one of the tablets to better aid her in drawing. However, the movement was so minimal, suggesting that the user was perhaps trying to avoid upsetting the group's dynamic. This suggests that the issues of conforming to public interests and conflict avoidance play a larger influence on multi-mobile users than has been previously merited.

Several findings imply a static positioning of users when they collaborate around multi-touch systems. For example, in a study performed by Lucéro et al. [14] about how users shared photographs using mobile devices, although it not explicitly implied, but the participants were seen to remain at their initial position during the task. As such, the author did not highlight any physical movement or relocation of users during the photo sharing activity. In another study by Marshal et al. [18], groups of users approached a digital tabletop to work on their tour plan of the area. Users were required to work together and could only proceed with their plan when all of them were in consensus of the plan. Their findings showed that users moved around the digital tabletop as they created the plan. We speculate that when collaborating around extended mobile devices with small screen size, the users tend to exhibit physical movement behaviours that are similar to the users in the study by Lucéro et al. [14] that is they tend to remain at their initial position throughout the task. Perhaps with a larger screen size comparable to a digital tabletop, users may relocate themselves, similar to the users in the study by Marshall et al. [18].

Figure-4 showed that participants remained static in both standing and sitting positions while they worked on the task. Another potential reason to explain the static positioning rather than the dynamic positioning is the notion of respect with each other, which is one should not interfere with others or in matters until it has been agreed by the society or community [16, 19]. This could potentially be translated into their behaviours when interacting around the MobiTop system, which is users would not enter into each other's workspace as it has not been discussed or agreed by the group. Moving around the MobiTop system could be seen as disrespecting others or going against existing norms, participants remained static

despite the inconvenience of having to draw complicated objects upside down.

IMPLICATION FOR DESIGN

We present the guidelines for designers when designing collocated ad-hoc collaboration applications using a multi-touch system:

(i) Rotatable individual mobile device with flexible connectivity

Mobile devices that are rotatable (can be orientated up, down, left and right) without losing its connectivity with other mobile devices within the grid system are highly desirable during collaboration. Users can rotate the mobile devices towards any direction to demonstrate their ideas to various participants. Of importance here is that the connectivity with other mobile devices in the system is still intact allowing for a seamless collaboration regardless of the dynamic orientation of the devices.

(ii) Public workspace on the multi-touch screens

In a small configuration of connected mobile devices (e.g. four mobile devices that are connected using the MobiTop system), it is likely that users will use most, if not all of the extended screen to perform group-like activities. It may not be necessary to segregate the spaces such as private or storage spaces due to the limited screen size. Hence, the screen size can be designed and maximised as a group space during collaboration.

(iii) Rotatable objects or screen.

It would be advisable that each drawn object or the entire screen on the multi-touch screen can be easily manipulated, such as rotate and scale, to support the various needs in collaboration.

(iv) Adding external objects

As the discussion progress, users may wish to add various external objects from other mobile devices or tablets into the discussion screen. For example, adding a picture of a landmark building to the discussion screen from one's mobile phones. This could facilitate a richer form of discussion as well as expanding the users' ideas and creativity.

CONCLUSION AND FUTURE WORK

We presented the findings of the study on the collaboration strategies applied by a group of participants when collaborating to complete a drawing on the MobiTop system. In general, the findings demonstrate the users found the setting of the system to be useful and valuable in supporting their collaborative experience. The extended screen size when combining multiple mobile devices

promotes easier interaction. Our study discovered that some of the current MobiTop features need to be improved such as, group-like orientation and static positioning when performing collaborative work on the system so that people can perform their collaborative tasks more efficient. Additionally, in the future work we would like to add more features on MobiTop setting so that people can perform their collaborative tasks more efficient such as the rotation and modifying on the objects; and explore if the devices can be extended to more than four devices. Innovation of the MobiTop system allows users to naturally collaborate anywhere and anytime simply by integrating their mobile devices, which in recent years has been an affordable item for the mass market. Users can socially engage and interact with each other to brainstorm their ideas and express their creativity through an extended screen size of the seamlessly integrative and connected mobile devices. The multi-touch aspects of the system promote simultaneous input contribution and potentially increase the success of the collaboration. We believe that MobiTop can provide the next step in the evolution of collaboration beyond tabletops and mobiles in this dynamic and social mobile environment.

REFERENCES

[1] Bellchambers, W., Francis, J., Hummel, E., & Nickelson, R. 1984. The International Telecommunication Union and Development of Worldwide Telecommunications. Communications Magazine, IEEE, 22(5), pp. 72-82.

[2] Chen, N., Guimbretiere, F., Dixon, M., Lewis, C. And Agrawala, M. 2008. Navigation techniques for dual-display e-book readers. In Proc. of CHI, ACM, pp. 1779-1788.

[3] Communication. n.d. Retrieved October 13, 2015, from http://www.merriamwebster.com/dictionary/com munication

[4] Dietz, P. and Leigh, D. 2001. DiamondTouch: A Multi-user Touch Technology. In Proc. of UIST, ACM Press, pp. 219-226.

[5] Deutsch, M. A Theory of Cooperation and Competition. J. 1949. *Human Relations 2*,(1) pp. 129-152.

[6] Fails, J. A., Druin, A. and Guha, M. L. 2010. Mobile collaboration: collaboratively reading and creating children's stories on mobile devices. In Proc. of IDC, ACM, pp. 20-29.

[7] Han, J. Y. 2005. Low-cost multi-touch sensing through frustrated total internal reflection. In Proc. of UIST, ACM, pp. 115-118.

[8] Higgins, S. E., Mercier, E., Burd, E. and Hatch, A. 2011. Multi-touch Tables and the Relationship with Collaborative Classroom Pedagogies: A Synthethic Review. J. Int. Journal of Computer-Supported Collaborative Learning 6, (4), pp. 23-31.

[9] Hinckley, K., Ramos, G., Guimbretiere, F., Baudisch, P. and Smith, M. 2004. Stitching: pen gestures that span multiple displays. In *Proc. of AVI,* ACM, pp. 23-31.

[10] Jamil, I., O'Hara, K., Perry, M., Karnik, A. and Subramanian, S. 2011. The Effects of Interaction Techniques on Talk Patterns in Collaborative Peer Learning around Interactive Tables. In Proc. of CHI, ACM, pp. 3043-3052.

[11] Jamil, I., O'Hara, K., Perry, M., Karnik, A., Marshall, M. T., Jha, S., ... & Subramanian, S. 2013. Dynamic spatial positioning: physical collaboration around interactive table by children in India. In Human-Computer Interaction–INTERACT 2013, pp. 141-158.

[12] Jokela, T. and Lucero, A. 2013. A comparative evaluation of touch-based methods to bind mobile devices for collaborative interactions. In *Proc. of CHI,* ACM, pp. 3355-3364.

[13] Joseph, S., Binsted, K., & Suthers, D. 2005. PhotoStudy: Vocabulary learning and collaboration on fixed & mobile devices. In Wireless and Mobile Technologies in Education, 2005. WMTE 2005. IEEE International Workshop on, pp. 5.

[14] Lucero, A., Holopainen, J. and Jokela, T. 2011. Pass-them around: collaborative use of mobile phones for photo sharing. In *Proc. of CHI,* ACM, pp. 1787-1796.

[15] Lucero, A., Keränen, J. and Korhonen, H. 2010. Collaborative use of mobile phones for brainstorming. In *Proc. of MobileHCI,* ACM, pp. 337-340.

[16] Kahn, J. S. 1998. Southeast Asian Identities: Culture and the Politics of Representation in Indonesia, Malaysia, Singapore and Thailand. Institute of South East Asian Studies.

[17] Kruger, R., Carpendale, S., Scott, S. D. and Greenberg, S. 2003. How people use orientation on tables: comprehension, coordination and communication. In *Proc. of GROUP*, ACM Press, pp. 369-378.

[18] Marshall, P., Morris, R., Rogers, Y., Kreitmayer, S. and Davies, M. 2011. Rethinking 'Multi-User': An In-the-Wild Study of how Groups Approach a Walk-Up-and-Use Tabletop Interface. In Proc. of CHI, ACM, pp. 3033-3042.

[19] Rao, P. 2002. Greening the supply chain: a new initiative in South East Asia. J. International Journal

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of Operations & Production Management 22,(6), pp. 632-655.

[20] Rogers, Y., Connelly, K., Hazlewood, W. and Tedesco, L. 2010. Enhancing learning: a study of how mobile devices can facilitate sensemaking. J. *Personal Ubiquitous Comput. 14*,(2), pp. 111-124.

[21] Rogers, Y., Lim, Y.-K., Hazlewood, W. and Marshall, P. 2009. Equal Opportunities: Do Shareable Interfaces Promote More Group Participation Than Single User Displays? J. Human-Computer Interaction 24,(2), pp. 79-116.

[22] Scott, S., Sheelagh, M., Carpendale, T. and Inkpen, K. 2004. Territoriality in collaborative tabletop workspaces. In Proc. of CSCW, ACM Press, pp. 294-303.

[23] Shen, G., Li, Y. and Zhang, Y. 2007. MobiUS: enable together-viewing video experience across two mobile devices. In Proceedings of the 5th international conference on Mobile systems, applications and services, ACM, pp. 30-42.

[24] Tandler, P., Prante, T., Müller-Tomfelde, C., Streitz, N. and Steinmetz, R. 2001. Connectables: dynamic coupling of displays for the flexible creation of shared workspaces. In Proc. of UIST, ACM, pp. 11-20.

[25] Yatani, K., Gergle, D. and Truong, K. 2012. Investigating effects of visual and tactile feedback on spatial coordination in collaborative handheld systems. In Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work, ACM, pp. 661-670.