Enhancing Engagement and Collaborative Learning Skills in Multi-touch Software for UML Diagramming

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Abstract: The use of Multi-touch interfaces for collaborative learning has received significant attention. Their ability to synchronously accommodate multiple users is an advantage in co-located collaborative design tasks. This paper explores the potential of Multi-touch interfaces in collaborative Unified Modeling Language (UML) diagramming by comparing them to a PC-based tool and evaluating the collaborative learning skills and level of physical interaction in both conditions. The results indicate that even though participants conversed more in the PC-based condition, the use of the Multi-touch table increased the level of physical interaction and encouraged "creative conflict" skills amongst the team members.

Introduction

The use of Multi-touch interfaces for collaborative learning has received significant attention, as they can accommodate more than one user at a time. This is particularly useful for learning through large, shared display systems, such as tabletops (Han 2005). Furthermore, the Multi-touch environment provides new opportunities for interaction between humans and computers. This area has been investigated by researchers from several different educational backgrounds, and they have found Multi-touch environments to be useful, as interaction through touch is both intuitive and natural (Ciocca, Olivo et al. 2012; Kolb, Rudner et al. 2012).

To the best of our knowledge, there has been little research to determine the potential of using Multi-touch tables to enhance co-located collaboration in software design using Unified Modeling Language (UML). Object-oriented analysis and design can be a very complex task, as it requires knowledge of requirements analysis, design, and UML. The problem statement is often vague and incomplete, and students require significant experience in order to be successful in analysis. UML is a complex modeling language, and students are commonly confronted by many problems before becoming skilled in it. Furthermore, UML modeling, like other design tasks, is not a well-defined process. There is no single best solution for a problem, and often there are several possible solutions to the same problem. The level of collaboration in Futura (Antle, Bevans et al. 2010) and WebSurface (Tuddenham, Davies et al. 2009) is limited and restricted to simple actions performed by users, such as putting words into the right context, arranging items over tables, and simple click-and-drag actions. However, UML design involves advanced design issues that highlight the need for new methods of collaboration, such as linking nodes and annotation. In this study, the potential of using Multi-touch technology for software design using UML is explored by comparing it with PC-based collaborative software design and examining the collaborative learning skills and physical interaction in both conditions.

The Experiment

Using Multi-touch table for collaborative UML diagramming has not been widely researched. To the best of our knowledge, there is no Multi-touch table based editor for UML diagramming available. Therefore, we have developed a Multi-touch collaborative UML editor named "MT-CollabUML" (Basheri and Burd 2012) to encourage face-to-face collaborative software design. In order to keep a same variable in both Multi-touch table and PC-based conditions, MT-CollabUML tool was used in both settings.

For the purposes of the research sixteen master program students who were studying "Software Engineering for the Internet" were selected. The participants were all familiar with collaboratively designing software using UML and had completed the course. The participants formed eight groups, each consisted of two people. A within-subject experiment was conducted to compare how the participants used PC with how they used Multi-touch table in terms of collaborative design.

Two separate tasks were implemented, each of which involved the creation of UML-State diagrams through a process of planning, discussion, decision making, drawing and reflection. In order to ensure that the tasks were of the same complexity and required the same level of skills, the course tutor was consulted. Counterbalanced measures design was conducted in this experiment to help keep the variability low. For every pair of groups, we gave one group a UML design task and asked them to complete it using the MT-CollabUML tool in PC-based condition (Figure 1). The other group was asked to complete the same task using the MT-CollabUML tool on Multi-touch table condition (Figure 2). Then the groups switched and were asked to

complete the second task using PC and Multi-touch conditions. Group member's learning experience and success are influenced by the quality of communication in team discussion (Jarboe 1996). Collaborative learning Skills includes Active Learning, Creative Conflict and Conversation (McManus and Aiken 1995; Jarboe 1996). According to Soller (2001) using Collaborative learning Skills promotes effective collaboration learning. Therefore, the verbal communication among each pair in both conditions were recorded and analyzed to find out if there were differences between conditions in term of type of verbal contribution. Baghaei (2007) and Soller (2001)'s verbal communication categories were used in this study. They include: "Request, Inform, Maintain, Acknowledge, Motivate, Argue, Introduce & Plan, Disagree, Task and Off-Task".

Figure 1: PC-based condition

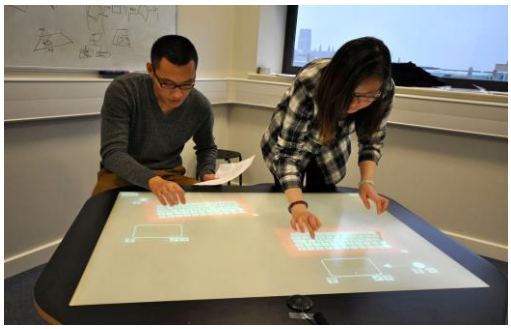

Figure 2: Multi-touch based condition

Conclusion

In this study, the differences in collaborative software design amongst groups of students working in PC-based vs. Multi-touch conditions were investigated. We hypothesised that the Multi-touch table would increase the effectiveness of the collaborative process by enhancing collaboration learning skills and increasing physical interactions amongst team members. The results indicate the benefit of using the Multi-touch MT-CollabUML tool as opposed to the PC-based version in enhancing collaborative software design. The Multi-touch environment increases the amount of physical interactions and subjects' engagements in the design activities. MT-CollabUML tool in the Multi-touch setting encouraged subjects to be engaged in a discursive conversation using "Creative Conflict" skills. More research needs be done in this area to fully explore the advantages and disadvantages of using Multi-touch tables in professional software design.

References

Antle, A. N., A. Bevans, et al. (2010). Futura: design for collaborative learning and game play on a multi-touch digital tabletop. Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction. Funchal, Portugal, ACM.

Baghaei, N., A. Mitrovic, et al. (2007). "Supporting collaborative learning and problem-solving in a constraint-based CSCL environment for UML class diagrams." International Journal of Computer-Supported Collaborative Learning **2**(2): 159-190.

Basheri, M. and L. Burd (2012). Exploring the Significance of Multi-touch Tables in Enhancing Collaborative Software Design using UML. Frontiers in Education Conference, Seattle, Washington, USA (in press).

Ciocca, G., P. Olivo, et al. (2012). "Browsing museum image collections on a multi-touch table." Information Systems **37**(2): 169-182.

Han, J. (2005). Low-cost multi-touch sensing through frustrated total internal reflection. Proceedings of the 18th Annual ACM Symposium on User Interface Software and Technology, Seattle, WA, USA ACM.

Jarboe, S. (1996). "Procedures for enhancing group decision making." Communication and Group Decision Making: 345-383.

Kolb, J., B. Rudner, et al. (2012). Towards Gesture-Based Process Modeling on Multi-touch Devices Advanced Information Systems Engineering Workshops. W. Aalst, J. Mylopoulos, M. Rosemann, M. J. Shaw and C. Szyperski, Springer Berlin Heidelberg. **112:** 280-293.

McManus, M. and R. Aiken (1995). "Monitoring computer-based problem solving." Journal of Artificial Intelligence in Education **6**(4): 307-336.

Soller, A. (2001). "Supporting social interaction in an intelligent collaborative learning system." International Journal of Artificial Intelligence in Education (IJAIED) **12**(1): 40-62.

Tuddenham, P., I. Davies, et al. (2009). WebSurface: an Interface for Co-located Collaborative Information Gathering. Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces. Banff, Alberta, Canada, ACM**:** 181-188