

Designing tools for supporting teachers' orchestration and awareness at a multi-tabletop classroom.

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Abstract: Multi-touch interactive tabletops have the potential to help students improve their collaborative activities by the design of learning environments that can offer an enriched space with digital information displayed through a traditional space of interaction: a table. A less explored potential of interactive tabletops is the capability to capture students' actions, and so to help teachers and researchers improve awareness of collaborative processes. An even more unexplored potential is to exploit the affordances of the interactive tabletop (as a digital medium that can provide support for social interactions and capture the digital footprints of students) to help teachers enhance control of the class and their awareness of the groups that might need more attention. Interactive tabletops, along with simple orchestration and awareness tools, can help teachers improve the way they manage their time and make students' collaborative learning more effective. This paper describes our steps in building two tools that help teachers enhance orchestration and awareness at a multi-tabletop classroom.

Introduction

Collaboration has proved to be effective in learning and instruction to help students achieve improved critical thinking, increased retention of new information, reduced on-task workload and a more positive attitude towards the knowledge domain (Johnson et al., 1986). However, groups of students that work face-to-face to build a learning artefact or engage in a problem-solving task do not necessarily work collaboratively (Dillenbourg, 1998). Collaborative learning includes a series of mechanisms that learners should aim to master. Teachers or facilitators should have the role of encouraging enhanced performance by monitoring the collaborative process, providing feedback in a timely manner and helping students to be more aware about their group dynamics (Dillenbourg et al., 2011).

Nevertheless, in traditional classrooms, teachers have to manage their limited resources and time to attend students' needs. The use of technology in the classroom has the promise to help students learn the curricula in a more effective way. In the case of small-group classroom activities, new pervasive shared devices such as interactive tabletops, interactive tangible systems and digital whiteboards, have the potential to enhance collaboration and learning. Different kinds of technology are now in the classroom. However, the technology itself cannot address all learners' requirements without adequate orchestration of both, technologies and students (Prieto et al., 2011). Research on Computer-Supported Collaborative Learning is converging towards the integration of the affordances given by technology, collaboration theories and the important role of teachers into a larger pedagogical real scenario: the classroom (Dillenbourg et al., 2009).

We particularly explore the potential offered by multi-touch interactive tabletops in the classroom to directly help teachers to coordinate multiple groups and indirectly help students to receive attention according to need. Multi-touch tabletops are promising in helping students to collaborate better as they share a common space of interaction and have access to digital materials as they can communicate face-to-face. Interactive tabletops can also capture traces of the collaborative process by processing students' input and sensing the context (e.g. speech, linked learning activities, status of the solution, students' position) (Martinez et al., 2012a). A less explored potential affordance of tabletops is in exploiting the interaction data of the group to help teachers to be more aware of the progress of each group on the group task and also to coordinate a number of groups working in parallel.

This paper presents a short description of a multi-touch tabletop system (Martinez et al., 2011a) that can capture a number of dimensions of the collaborative students' interactions and the work in progress towards two tools that can be used by teachers to enhance classroom control and awareness. The first tool is a teacher's dashboard (Martinez et al., 2012b) that can run on a handheld device, tabletop or personal computer. This shows a set of visualisations of different aspects of group members' participation at an interactive tabletop. Then, we describe the work in progress on a second tool that consists of both a visual overview of the level of interaction of the group, and basic commands to orchestrate the script of a multi-tabletop classroom.

Related work

The most significant work on orchestration at a multi-tabletop classroom was reported by AlAgha et al. (2010). The authors presented an interactive tabletop that can help a teacher monitor multiple groups working on a task performed at up to four tabletops. Teachers can monitor and directly interact with a specific group's tabletop or

simply decide to attend to groups that need closer guidance. By the end of the activity, teachers can also use this tool to replay the process followed by certain groups to help students reflect about their collaborative interactions. Dillenbourg et al. (2011) presented some minimalist tools to increase a teacher's awareness of the progress of small group activity, with coloured lamps and the use of paper cards to control interactions in tangible interactive tabletops. Another example is given by Twiner et al. (2010), who presented work on classroom orchestration by providing tools for the teacher to control the class using an interactive whiteboard. Martinez et al. (2011b) reported the evaluation of a set of visualisations of collaboration at the tabletop showing that these can improve teachers' awareness, enabling them to detect groups with potential problems. Our work differs from previous work by exploring ways to automatically exploit interaction data to increase teacher's awareness and provide them with simple functions for controlling the multi-tabletop class.

Multi-tabletop environment

Our multi-tabletop environment builds on multiple instances of Collaid (Martinez, et al., 2011a), a system that augments a conventional multi-touch tabletop to afford: users' touch detection; speaker differentiation; and multi-dimensional data logging (snapshots of the tabletop status, interaction data and low level input). Figure 1 shows the overview of our approach. (1) Multiple instances of our tabletop system capture information about students' interactions. (2) We exploit this data by looking for meaningful patterns (using data mining) and generating visualisations that can help teachers identify potential problems in some groups. (3) We designed two teacher dashboards to present the results in a visual manner. In this paper we focus on presenting the tools we designed for this step. Finally, (4) teachers can take actions to provide support to some groups and to orchestrate the whole activity.

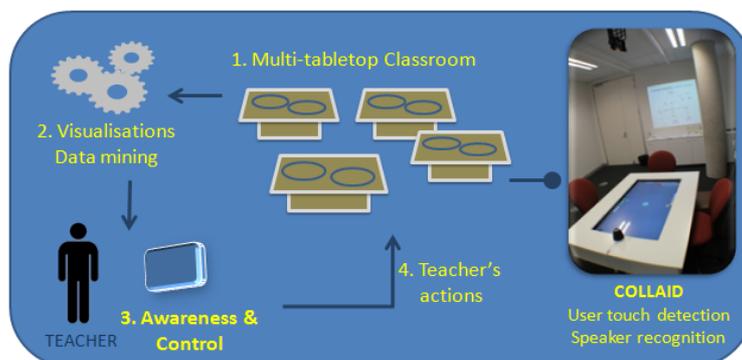


Figure 1. Multi-tabletop environment to enhance teacher's awareness and classroom control. 1. Multiple instances of the COLLAIID capture environment. 2. The collected data is analysed to generate visualisations and find patterns. 3. Orchestration tools. 4. Teacher's action performed through the tools or directly with the students. At the right, the figure shows one tabletop, the Kinect and microphone array.

Awareness and orchestration tools

Dillenbourg et al. (2010) listed a set of factors to take into account when designing teacher-centric learning environments for classroom orchestration. These indicate that the tool should present orchestration factors such as providing teachers with leadership, flexibility and control over the class; helping teachers manage their time; being easy to use (minimalist) and sustainable, since it has to be used many times, for a number of classes one after the other and under time constraints. The first tool we describe is a visualisation dashboard (Figure 2). The aim of this tool is basically to increase teachers' awareness. Thus, the design focuses on orchestration. The second tool is a controller dashboard that helps a teacher to run a series of repeat tutorials, with different classes, one after the other. For this purpose, the teacher needs to be at the centre of the action and be able to manage all tabletops at once to keep control of the enactment of the class script. Next we describe details about each tool.

Teacher's visualisation dashboard

It is not an easy task to define the best ways to present information about group collaboration so that it is readily understood by teachers. The goal of this tool is to present real time data from interactive tabletops, combined with data mining results, in an interactive dashboard that helps teachers monitor multiple groups' activities. This dashboard includes three visualisations of three groups working in parallel at interactive tabletops. Figure 2 shows a snapshot of this dashboard on a handheld device. The visualisations were designed and evaluated by teachers experienced in small-group classroom activities. There is a "collaboration meter" that displays the extent of collaboration as modelled by a data mining classification technique (visualisations in the column of white meters in the middle of the screen on Figure 2); a graph that shows the number of times each student interacted with objects created by others (middle column, Figure 2); and a combined radar of physical (touches) and verbal participation of each group member, depicting both the amount and symmetry of participation of each student (right most column, Figure 2). Results of a user evaluation indicated that the dashboard enabled

teachers to detect which groups encountered problems in terms of collaboration (Martinez, et al., 2012b). They were able, for example, to detect when a student was highly dominating the activity without allowing others to contribute, or when the students were working completely independently. While the activity that learners performed at the tabletops was to build a collaborative concept map on a given topic (Martinez et al., 2010), the visualisations in this dashboard can be used for other domains and activities.



Figure 2. A teacher’s dashboard that shows visualisations of three groups working at multi-touch tabletops. These visualisations include, from left to right, a collaboration meter (white), a physical interaction graph and a combined audio/touch participation radar. For more details please refer to (Martinez, et al., 2012b).

Teacher controller dashboard

In a real classroom, it may be infeasible for teachers to try to understand large amounts of data, even when presented in a friendly form. For some teachers, it might be more helpful to have access to tools that are easy to use and that help them to control the whole class for example to gain the attention of the students to provide some important instructions. The form of functionality can enable interactive tabletops to offer improved classroom management. We designed a tool, driven by the special requirements of a multiple interactive tabletop classroom activity that ran as a one hour tutorial class in a subject with more than 250 university students. The teacher formed four groups of up to six students in each class. Students were asked to solve a problem and build a graphical representation of their solution at the tabletop. The design of the group task for this case was scripted by the teacher and has 4 stages: 1) The presentation and reading of a real case scenario related to a topic of a subject in Management. 2) The construction of a graphical representation of the structure of an organisation in the form of a concept map. 3) The visual representation of a solution for the case study. 4) Group reflection at class level in which each group had to explain their solution to other groups. In this learning scenario, for each session teachers need to manage their limited available time per class (up to 50 minutes) to explain the purpose of the task, deal with potential technology issues, run the activity and provide some class feedback. There can be up to six sessions in one day, one after the other. In this situation we needed to provide teachers with considerable control over the class rather than awareness.

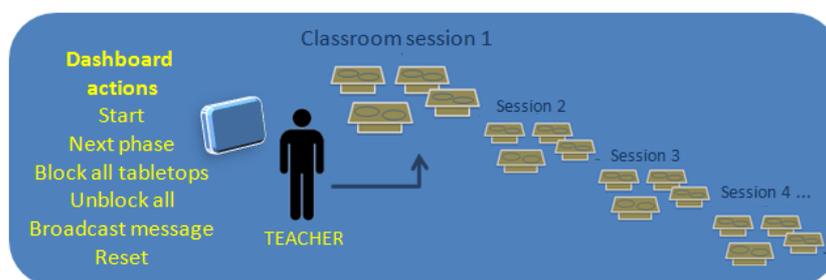


Figure 3. A controller dashboard for a teacher that needs enhanced time management and scripting of an activity that has to be repeated during multiple sessions.

As a result, we designed a teacher’s controller dashboard. The user interface is simple; it offers only five actions that the teacher can perform to orchestrate each tutorial (see Figure 3). These actions include a synchronous *start* command to order all the tabletops to restart the activity at the same time. Teachers can order all groups to move from one stage to the next. This requirement was formulated by teachers who, in this particular case, indicated that all groups should finish the parts of the activity at the same time. In other scenarios it might be acceptable that each group works at their own pace. In our case study, the tabletop

application provides students with different resources in each step. Teachers also suggested the addition of a “blocking” feature, to block all tabletops in case the technology distracts the students when the teacher needs to provide instructions or encourage reflection. Teachers also wanted to have the option to broadcast a message to all the tabletops, for example, a gentle time limit reminder that appears on each tabletop to make sure that all groups are aware of the time frame. Finally, after a class is finished, the system is able to easily reset the application on all tabletops to get ready for the next class session with different students. This saves all the information about the solutions and interaction data for further analysis. Optionally, teachers can choose to have one visualisation for each group shown at the dashboard to help them detect groups with potential problems (similarly to the visualisation dashboard).

Conclusions and work in progress

We presented our rationale behind the design of our tools to enhance teacher control and awareness of small-group learning activities supported by multi-touch tabletops. We are exploring ways to enhance the usefulness of interactive tabletops in addressing the requirements designed by university teachers. Our preliminary findings indicate that interactive tabletops can provide useful information and affordances for teachers to tackle current monitoring and management problems in the classroom. Work in progress includes the evaluation of these tools during real university tutorials. We aim to evaluate the effectiveness of our system to help teachers to orchestrate a classroom and multiple classroom sessions in a row. We also aim to extract patterns of students’ interactions from the digital footprints that they leave as they work together around the digital tabletops, to automatically detect potential issues and fire alarms that can help teachers to better direct their attention to groups that need guidance.

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