Multi-touch technology to support multiple levels of collaborative learning in the classroom

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Abstract: While much research on collaborative learning has focused on what goes on within groups to lead to success, in this paper, we consider the classroom context within which collaborative learning occurs. Drawing on concepts of classroom orchestration and repertoires of collaborative practices we discuss how multi-touch technology can be used to support collaborative learning in classroom settings. Data drawn from three classes of sixteen students, organized in four groups of four, is examined to identify how the movement between small group and whole class interaction supports the collaborative engagement, finding that the whole-class discussion prompts a move to higher levels of reasoning within the groups.

Introduction

While research has repeatedly shown the value of collaboration to support knowledge building, problem solving and learning (see, Barron & Darling-Hammond, 2008) evidence indicates that this form of learning is rarely, if ever, used in actual classrooms (Baines, Rubie-Davies, & Blatchford, 2009). However, the development of multi-touch technology (Dillenbourg & Evans, 2011; Higgins, et al., 2011) combined with efforts to understand the importance of fully integrating technology into the classroom environment suggests the possibility of more easily supported collaboration in classrooms, leading to more frequent use of this pedagogic strategy.

Current research into the use of multi-touch technology for learning has largely been limited to an exploration of groups working on a single table, rather than the interaction of multiple devices in a classroom. This research indicates that multi-touch tables can lead to more task focused, and less process focused talk than single-touch tables (Harris et al., 2009), that they can both better support the development of a joint problem space (Higgins et al., in press) and increased communication and cohesion (Evans, et al. 2011). These findings suggest that multi-touch technology can be used effectively to support the interaction of groups during a learning activity, and the potential of such tools to be integrated into formal learning environments.

While much research has focused on the role of new technologies to support learning, rarely has the work considered the implications of the changes these technologies can bring to classroom communities, and the necessity of more widespread change to the classroom norms to take full advantage of these new tools. Slotta, (2010) suggests that the relative lack of uptake in new forms of pedagogy, despite consistent research that shows it is beneficial to learners, is due to the profoundly disruptive effect these pedagogies have on classroom communities. He proposed that new forms of technology could be used to support the transition to more revolutionary approaches to learning and teaching in the classroom, with technology specifically designed to support some of the complexity of the learning environment. Dillenbourg & Jermann (2010) defined 14 features of classroom ‘orchestration’ that need to be taken into account when embedding new technologies into classrooms. In our work, we consider the potential disruptive effect that both technology and collaborative learning can have on traditional classroom learning, and examine how this technology can be developed in such a way as to support the teacher’s orchestration of the classroom, while at the same time supporting the integration of this form of learning.

The orchestration of collaborative learning requires attention to multiple levels of activity, including the individual participant, the interpersonal interactions, both in relation to the problem and relational spaces, the context of the learning and the community practices (Barron et al., 2009). In our project, we have designed a multi-touch integrated classroom, with four student multi-touch tables, a multi-touch interactive whiteboard and a teacher’s multi-touch desk which can be used to control the student tables and interactive whiteboard (see figure 1); the room is also equipped with multiple cameras and microphones. This allows us to examine the individual learner, the interaction within groups, the between group and whole class interactions and how the teacher manages the classroom. In this paper, we focus on how the movement between small group and whole class discussion influences the interaction and conversation within the groups.

Method

Three schools participated in this study of the multi-touch classroom. Sixteen students from each school consented to participate after completing introductory activities in their classroom. Students were in their final year of primary school, and were between 10 and 11 years old. Each school group came to the lab on a different day and stayed for up to five hours. They were taught by one of two former primary school teachers, who were members of the research team; one teacher taught two of these classes, while the second taught one class. For
two schools, students were seated in same-gender groups of four, while the students from the third school sat in mixed groups of two male and two female students in accordance with the overall project research design. A number of activities have been designed to help the students become familiar with the tables and how to use them. After completing these activities, the students worked on a number of history and mathematics tasks. The data for this paper is drawn from the history data.

The task
The history task, which is described in detail elsewhere (Higgins et al., in press) was based upon an incident in a coalmine in 18th century north-east England. At the start of the task the teacher read aloud a statement about the accident, in which a 10 year old boy, Robert Dixon, lost his leg. The children then received 16 clues to help them determine what happened to Robert Dixon and who was responsible. This task is designed to encourage divergent argumentation, with multiple possible answers (adapted from Higgins, Baumfield & Leat, 2001) and is an example of a ‘mystery’ pedagogical strategy (Leat and Higgins, 2002). The task was introduced by the teacher who then “unlocked” the tables and allowed the groups to begin to make sense of the task by reading and connecting the pieces of information. The teacher then orchestrated the activity, moving the groups between small-group conversation and whole-class discussion to facilitate argumentation and problem solving.

Data
Video was collected for each group, using cameras that are placed in the ceiling; a fish-bowl camera provides a view of the entire room. Each table has a microphone, and the teacher wore a lapel microphone during the class. The audio was transcribed verbatim, using the project’s analysis tool (Fig 2). In this tool, transcripts are laid along a time-line, and each participant is represented as a separate line, into which their utterances are transcribed. Analysis is conducted directly onto the transcript, allowing coding to be examined over time.

Coding
The videos were coded using an adaptation of the SOLO taxonomy, which provides a hierarchy of reasoning complexity (Biggs & Collis, 1982; Moseley et al. 2005). This scheme was selected because it allows for an exploration of how the groups are making sense of the mystery, and the levels of relational complexity.
emerging from the group. The coding scheme, and how it was adapted for use for the mystery, is shown in table 1.

Table 1: SOLO taxonomy adapted for ‘Robert Dixon’ mystery

<table>
<thead>
<tr>
<th>Color</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre structural</td>
<td>Turquoise</td>
</tr>
<tr>
<td>Unistructural</td>
<td>Blue</td>
</tr>
<tr>
<td>Multi-structural</td>
<td>Purple</td>
</tr>
<tr>
<td>Relational</td>
<td>Red</td>
</tr>
<tr>
<td>Extended abstract</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

Results

The history mystery lasted about half an hour (M = 26 minutes, 39 seconds; SD = 3 minutes, 7 seconds). In each class, the teacher introduced the activity and sent the clues to the four tables. The teacher stopped the groups twice during the task for a discussion and brought the class to an end with one final group discussion. In each instance, the focus of the first discussion was about how the group was going about the task, while the second class discussion was focused on what explanation the students were finding for the problem.

Table 2 shows the highest level of reasoning reached within each group in each of the small-group discussion phases of the task. While the data shows that there were some groups who did not appear to engage with the task (e.g. Yadstone Yellow or Shadbrook Yellow), eight of the 12 groups moved onto a more complex form of reasoning during the task, reaching higher levels of reasoning in the final group time session. Five of the groups were able to offer an explanation who was responsible for Robert Dixon’s injuries, showing relational and extended abstract thinking.

Table 2: Highest level of reasoning in each group in each time period

<table>
<thead>
<tr>
<th></th>
<th>Group Time 1</th>
<th>Group Time 2</th>
<th>Group Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yadstone Red</td>
<td>Prestructural</td>
<td>Prestructural</td>
<td>Unistructural</td>
</tr>
<tr>
<td>Yadstone Blue</td>
<td>Multi-structural</td>
<td>Multi-structural</td>
<td>Relational</td>
</tr>
<tr>
<td>Yadstone Green</td>
<td>Unistructural</td>
<td>Unistructural</td>
<td>Multi-structural</td>
</tr>
<tr>
<td>Yadstone Yellow</td>
<td>Unistructural</td>
<td>Unistructural</td>
<td>Prestructural</td>
</tr>
<tr>
<td>Benbrook Red</td>
<td>Unistructural</td>
<td>Unistructural</td>
<td>Extended Abstract</td>
</tr>
<tr>
<td>Benbrook Blue</td>
<td>Multi-structural</td>
<td>Multi-structural</td>
<td>Extended Abstract</td>
</tr>
<tr>
<td>Benbrook Green</td>
<td>Relational</td>
<td>Relational</td>
<td>Relational</td>
</tr>
<tr>
<td>Benbrook Yellow</td>
<td>Unistructural</td>
<td>Unistructural</td>
<td>Unistructural</td>
</tr>
<tr>
<td>Shadbrook Red</td>
<td>Multi-structural</td>
<td>Multi-structural</td>
<td>Relational</td>
</tr>
<tr>
<td>Shadbrook Blue</td>
<td>Prestructural</td>
<td>Prestructural</td>
<td>Unistructural</td>
</tr>
<tr>
<td>Shadbrook Green</td>
<td>Multi-structural</td>
<td>Unistructural</td>
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<tr>
<td>Shadbrook Yellow</td>
<td>Unistructural</td>
<td>Unistructural</td>
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</tr>
</tbody>
</table>

In the examples that follow, segments of the coded transcript are displayed, to show how the coding scheme was applied, and identify the changes in discussion over time. One group from each school was selected to show the different patterns of change in their reasoning through the task (note the participants are identified by a letter and number at the start of their transcript line; in order to show as much group conversation, the introduction and final discussion have not been included in the images below).

In the first example, Yadstone Blue, the students spend some of the first group time reading the clues aloud, without making substantial comments about their value (indicated by the turquoise pre-structural code). Towards the end of this first group time, we see one comment that is coded as multi-structural (purple) and one that is coded as unistructural (blue), indicating the group are beginning to make sense of the clues in relation to the problem. During the second group time, this group initially pick up some of their ideas from before the class time, but then go back to reading more clues, beginning to reason about them in more complex ways (identified by the purple codes) towards the end of group time two.

This group struggle with some distraction at the beginning of the third group time, reading the timetable for the day off the whiteboard behind them, and discussing what time they have to return to school.
However, they return to the topic, reaching the relational level of reasoning (shown in red) in the last minute before the teacher calls the class to an end. The Benbrook Blue group show a more complex pattern of engagement than the Yadstone Blue group, with more students involved in the discussion (this can be seen from the more scattered pattern of colored utterances, as well as a greater density of utterances as a whole). As with most groups, some time is spent just reading the clues, but the Benbrook Blue group also begin discussion of the relevance and inter-relatedness of the clues during the first few minutes, as can be seen in the unistructural utterances (blue), made by pupil b27 at the beginning of group time 1. By the end of the first group time, pupils b26 and b27 are making multi-structural comments (purple), which b27 shared with the class during the class time between group time 1 and 2. During the second group time, the conversation is more balanced within the group, with pupils b26 and b27 contributing comments that were identified as multi-structural (purple). The group also returned to reading some of the clues to further build their argument (turquoise) and evaluated the new clues in light of their reasoning about the task (blue and purple codes). Again, b27 contributes to the whole class discussion; although it is not clear in this view, b27 puts forward a relational statement in answer to the teacher’s questions during the whole-class discussion. In the final, short group time, b27 brings together all the comments, making an extended abstract statement.

Example 1: Yadstone Blue

Example 2: Benbrook Blue

Discussion
The process of collaboration using multi-touch surfaces in a classroom environment was explored in this paper. Drawing on the repertoires of collaborative practices framework (Barron et al, 2019), collaboration was viewed as taking place on a number of planes simultaneously; the analysis begins to look at the movement between two of these planes: the interpersonal and the context, and investigate how they might influence each other.

The results indicated that eight of the twelve groups moved to higher levels of reasoning throughout the task, while two remained at the unistructural level throughout the task, one remained at the relational throughout and a final group and one moved from unistructural to prestructural in the final group time. The groups who did not improve during the task can be explained by examining the content of their interactions. Benbrook Green began discussing the task at a high level, moving quickly to the relational level, and continuing to return to that level of discussion across the three group sessions. In contrast, neither Benbrook Yellow or Shadbrook Yellow moved above the unistructural level, while Yadstone Yellow worked at the unistructural level for the first two group sessions, finishing at the prestructural level. When examined, all of these groups struggled with relational interaction issues, arguing over turn taking, levels of participation, and issues unrelated to the task, rather than attending to the activity beyond the most superficial of reading and beginning to make sense of the clues.

The progressive improvement was expected, as students learned more about the task, however, the specific changes during and after the whole class interactions showed the influence of the classroom context on the groups. In almost all cases the students remain at the same level of engagement after the first whole-class discussion, where the teacher mainly focused on procedural issues. However, during the second whole-class discussion, the teachers asked the groups to describe what they thought had happened to Robert Dixon, and whose fault it had been. By projecting one of the table’s content to the large whiteboard in the room, the groups explored whether they were making similar decisions to the other groups in their class. The projection also gave the groups a common reference to discuss their progress, and created a source of joint attention for the class.
The two examples provided a different perspective on how the groups functioned within the classroom. While there is more to be explored in terms of the interpersonal interactions within the groups, and the types of contributions made by each group member, the patterns of each group time, and how the groups are influenced by the whole-class discussion should be considered. The Yadstone Blue group make very few contributions to the whole class discussion, and yet reach the highest level of reasoning of any group from that school, and were likely the most on-task of the Yadstone groups throughout the task. They appear to be distracted from task when the whole-class discussions occur, reaching higher levels of reasoning towards the end of each group time, but not picking up at the same level after the whole-class discussion.

In contrast to Yadstone Blue, Benbrook Blue appear to have been able to use the whole class time to move their thinking forward, particularly as their self-selected spokesperson, b28, used the whole-class discussion as a place to report higher levels of reasoning than he had actually contributed within the group. This group also showed a more balanced range of contributions from all group members, with everyone making comments that were coded as unistructural and multi-structural at some stage during the activity.

Across the twelve groups, the whole-class discussion proved to have both a positive and negative effect on the groups. At times, stopping the group task causes disruption to the group process, that the groups could not immediately recover from, while in other instances, the whole class discussion appears to have prompted the groups to think about the task in more depth, pushing them into a higher level of reasoning, either during the class discussion, or when they returned to their group conversation.

The data from this paper indicates a complex interaction between the small groups and whole class discussions, that is mediated, supported by, and possibly disrupted by, the teacher’s ability to lock the tables and project the content of one table to the whole class. The technology provides equal access to the content, although, as can be seen from the three examples, as well as the range of reasoning levels reached by the twelve groups, it does not guarantee equal participation or engagement with the task.

While this paper has focused on the interpersonal and context levels of analysis of the groups, one feature of the data is what appear to be differences between the school groups. The groups from Benbrook reached higher levels of reasoning than the students in from the other two schools, suggesting that the students may have been bringing community practices of engagement in collaborative learning to the lab classroom, which altered how they interacted with each other, the technology and the task.

References


