The Four Ts of the Collaborative Classroom

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Abstract: Drawing on a multi-year study of using multi-touch tables in a classroom setting, this paper lays out a framework to use when designing and studying collaborative classrooms. The framework identified the overlapping aspects of teachers, tasks, technology and teams, as being essential features of the use of computer-supported collaborative learning in classrooms. We argue that the design of collaborative classrooms should take this model into account during design and evaluation phases. This paper contributes to the Methods and Techniques strand of the Orchestrated Collaborative Classrooms Workshop.

Keywords: CSCL; Classroom Orchestration; Design; Interactive surfaces

Introduction

A review of the literature indicates that the concepts of computer-supported collaborative learning has been expanding in the last decade, with a range of technologies, locations and types of interaction being used to promote learning. And as the range of technology increases, so does the possibility of integrating a range of devices into learning environments to support different types of learning, interaction and teaching (Slotta, 2010). While these advances create opportunities for the design of new types of learning to occur, this must be done in a backdrop of theory that places the technology, the desired learning, the learner and the context into frame (Laurillard, 2008; Luckin, 2003). There is a need to understand, not just the individual designs of learning experiences, but how they fit together in a complex learning environment (Anderson & Shattuck, 2012).

Drawing on a range of our previously published work from a multi-year design research project that focused on the creation of a multi-touch classroom, we propose a model for future technology-enhanced classroom designs. This model draws on four main aspects of the classroom – teachers, teams (of students), tasks and technology – set within the context of the learning environment (see Fig 1). The goal of this paper is to use some of our findings to elaborate this model and how it can inform the design and research of collaborative classrooms.

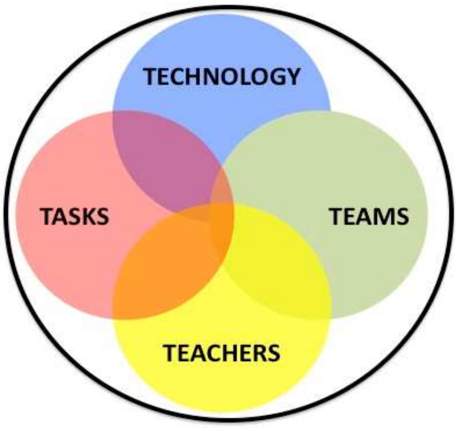

Figure 1. The 4Ts Framework

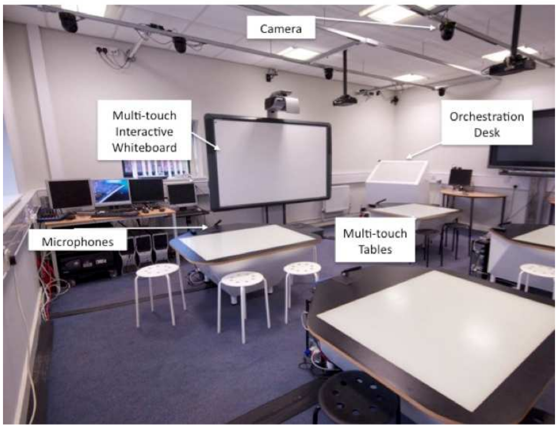

Figure 2 The SynergyNet Classroom

The design of computer-supported collaborative learning environments requires the exploration of multiple perspectives and dimensions in order to create a complete understanding of the issues and influences on the learning experience. We propose that there are four key aspects that need to be considered; by themselves and in the ways they each impact the rest of the system. These aspects – teams, teachers, technology and tasks – are often studied in isolation or in some combination, but we argue that building a CSCL environment requires that they all must be considered.

Detailed exploration of these four aspects exist across the literature on CSCL, classroom technology and collaborative learning more generally – from the detailed work on collaborative learning both with and without technology and work that specifically compares how different technology influences learning, to work that examines how teachers should support collaborative groups and that looks at the role of the school structure and teacher in using technology in the classroom. In addition, research that examines the overlap between these, such as much of the research on computer-supported collaborative learning (teams and technology), TPCK (Mishra & Koehler, 2006) or classroom orchestration (teachers and technology), and scripting or modeling collaborative behaviors (teachers and teams). These provide a rich place to start examining CSCL, however, alone none provide sufficient scope of the problem of using technology to support collaborative learning in classroom environments.

Building on this literature, we propose a framework that takes from each of these, recognizing the complexity of each of these aspects, but that it is in attending to the confluence and interaction of the four aspects of the framework that we believe we can learn the most about the use of technology to support collaborative learning. While each of the four planes have been described, the main goal of this framework is to consider the intersections between planes, and how they influence the design of CSCL environments. To elaborate the interplay of these planes, findings from the SynergyNet Classroom project are described, showing how pieces of this larger project fit into the different dimensions and, together, provide a richer understanding of the issues that arise when integrating technology to support learning within classrooms.

Methods

As part of a design-research project, a classroom of multi-touch tables was developed (see Figure 2), with a range of activities for use by students in the upper years of primary school in the UK (i.e. 8 and 11 years old). Over a four-year period, a series of studies were conducted in the lab classroom. The initial study explored single groups using a multi-touch table with a teacher present. Later studies focused on bringing up to 16 children from the same class into the lab classroom for one or more days of lessons, including one study that brought students from six different schools into the lab for a full day. In the studies described here, all students worked on a series of math and history tasks which are described in detail in the full papers.

The multi-touch classroom was equipped with video, audio and screen capture technology to collect data on the groups and classroom interactions and learning. The video, screens and audio were synced, and transcribed for analysis. Pre and post-test measures were also conducted in the lab or schools when necessary. In the section below, summaries of findings will be presented to illustrate how the data from this project is used to build an understanding about designing collaborative learning environments for classrooms.

Summary of Findings

Technology & Teams

In our initial study, we compared students using a multi-touch table or completing paper-based version of the same activity, to understand if the technology influenced the collaborative processes. Eight groups of four students completed this within-subjects experiment, completing one task in the multi-touch condition and one task in the paper-based condition. Groups started work on a history task, and then completed 3 math tasks in the second condition. In each task, a teacher was present who aimed to help the students complete the task. Analysis of the group processes during the history task found that groups using multi-touch engaged in more interactive statements, building on the ideas that their team-mates introduced, than groups in the paper-based condition (Higgins et al, 2012). Analysis of the math data showed a similar pattern, with groups who used the multi-touch table engaging in more statements that elaborated on ideas or combined ideas with ideas raised by their team-mates (Mercier et al, 2013). These results show that across conditions, groups act differently, engaging in more interactive discussion when completing tasks in the multi-touch condition than in the paper-based condition.

Task and Teams

Understanding the role of technology in supporting collaborative learning requires that we understand not just the relationship between the tools and teams, but also how different tasks and content areas influence the way groups interact, and how that impacts on what we can conclude from the use of particular technologies. In the six-school study, we compared groups working on history and mathematical mystery tasks. In an exploration of the types of leadership that emerged within these groups (Mercier et al, 2014) we found that although group membership was the same across tasks, different people emerged as leaders, and different amounts of leadership were seen in the two content areas. While the tasks in the two content areas were similarly structured, the history task was a divergent activity, with a range of possible situations, while the math tasks had correct answers, which may have influenced how students felt they should interact with their group. One key feature of this finding is that it suggests that beyond the technology or the learners involved, the task and content area can influence how group members interact, and our findings of the value of that technology for supporting their collaborative learning, as a result.

Teams and Tasks in the Classroom Context

During a 6-school classroom study, the organization of the room was altered in order to explore whether there was any difference when the tables faced towards the front of the room, in a more traditional set up (students sit around 3 sides of the table, thus the unused side faces the interactive whiteboard and teacher desk), than when the tables faced the center of the room, making for a more collaborative classroom design. During math tasks, results indicated that groups in the traditional classroom solved the tasks more frequently than groups in the centered classroom. However, groups in the centered classroom had higher levels of on-task discussion than groups in the traditional classroom. These findings suggest that groups in the traditional classroom were focused on solving the problem, while groups in the centered classroom were focused on collaboratively discussing the task, so that more students were involved in the conversations in the centered classroom, which may have influenced the time it took them to solve the problems (time on task was fairly constant across conditions). This study highlights the importance of attending to how the organization and placement of technology within classrooms can influence the way groups engage in collaborative activities (Mercier et al, in press).

Technology, Teacher & Teams

The role of the teacher in supporting the use of CSCL in classrooms has had less attention, and understanding how to design orchestration tools for technology-enhanced classrooms is less clear (Dillenbourg & Jermann, 2010). The multi-touch classroom was initially designed so that the teacher could control the student tables from an orchestration desk in one corner of the classroom, sending content to the student tables, observing the student tables, and projecting from the student tables to the interactive whiteboard to facilitate whole-class discussions. In a six-school study, the use of the projection system was explored. During the history task the teachers allowed the groups to work in small groups for three time periods, with two whole-class discussions on progress and a final whole-class concluding discussion. This allowed us to examine the role of teacher intervention at the whole class level, the value of projecting the content of a group's table to the shared interactive white-board, and the way in which the teacher could use the technology to facilitate the uptake of ideas between groups. Paying attention to how students changed in their reasoning about the history mystery after whole-group discussion times, we used the SOLO taxonomy (Biggs & Collis, 1982), to identify the highest level of reasoning in each period of small-group discussion. As expected, most groups moved to higher levels of reasoning over the course of the task, moving from lower levels in the first and second small-group times, to higher at the third. However, it was also clear that the groups moved to higher levels of reasoning after the second whole-group discussion, at that stage elaborating their comments in more detail and tying their ideas together. The key issue that seemed to be at play here, however, was that groups appear to take the ideas that they contributed to the whole class discussion, and develop those within their small group, rather than building on ideas or reasoning structures shared by other teams. This suggests an important role for the classroom 'audience' in supporting the increase in reasoning and argumentation within groups (Mercier et al., 2012).

Conclusion

While the four results described here each take different pieces of the model into account, taken together, they begin to build a more complex picture of what occurs when technology is used to support collaborative learning in a classroom environment. The initial study, which examined how groups interacted between multi-touch tables and paper, indicated that the technology supported greater levels of joint attention and the shared development of ideas. However, this finding is not sufficient to place the technology in classrooms. The second two studies show that *where* the technology is in the classroom, and *what* content the students are working on, can both influence their problem solving success and interaction behaviours. The final study presented indicates that the movement between small group and whole class discussion plays an important role in the way students engage in a task.

Taken as a whole, these four results show that the use of multi-touch tables for collaborative learning in classrooms is far more complex than is suggested in the initial comparison study (teams and technology). The technology may lead to better collaborative behaviors, but the influence of the broader context of the classroom, the role of the teacher and classroom peers and the task design and content area must be considered. This range of studies (including more studies beyond those described here) indicates the importance of designing computer-supported collaborative learning tools with a view to assessing them in the classroom and curricular context and creating them in concert with tools for teachers to orchestrate the learning. The framework proposed here should serve as a guide for development projects, informing the design of CSCL tools through the multiple lenses that are available in the framework, and be an impetus for design and research studies that go beyond the basic evaluation of the interaction between the tool and learner, but look at the context more broadly.

For example, a new project that intends to explore the value of multi-touch surfaces to support collaborative sketch activities in introductory engineering courses (as is currently being conducted by the first author), will be concerned with the development of sketch tools for interactive surfaces and the human-human-computer interaction when using these tools. However, drawing on the framework, the tool development will also consider 1) the tools that a teacher would need to orchestrate the interactions and tool use, 2) the classroom environment in which these tools will be used, 3) the type of interactive surfaces that the tool might be used on, and how that would influence interactions and learning opportunities (e.g. tablets, large screens, tables) and 4) the manner in which this tool may be used for content areas beyond introductory engineering. Studies of these tools, therefore, will go beyond the traditional evaluation of the learning that occurs when students use the tools, but will also include implementation in a range of classroom environments, with different types of teachers and learners. The tool development will also include tools for the teacher to use when orchestrating the learning experience, and examine the potential for tools to support evaluation and assessment activities during and after the activity.

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