Scripting and orchestration of collaborative inquiry: An increasing complexity of designs

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Abstract: The emergence of increasingly social and connected technologies is providing new opportunities for computer supported collaborative learning designs, (e.g., user-contributed content, tangible and embodied interactions, and augmented reality), while raising challenges and complexities in the scripting and orchestrating of these interactions. This poster responds to these challenges, introducing an orchestration framework (S3) within the context of two grade 11 physics classes in a smart classroom setting.

As CSCL interventions become increasingly complex in terms of the interactions we require between students, teachers, materials, and the learning environments, there is a growing need to structure these interactions in the form of pedagogical scripts (Dillenbourg & Jermann, 2007). Further, with the increasing complexity and duration of our CSCL scripts, there is greater need to give teachers the information and tools to orchestrate their enactment – even as they may unfold "on-the-fly" (i.e, requiring real-time decisions). Orchestration is achieved through direct social interactions as well as through technological supports. In response, we are developing SAIL Smart Space (S3), an open source framework that coordinates complex pedagogical sequences, including dynamic sorting and grouping of students, and the delivery of materials based on emergent semantic connections (Tissenbaum & Slotta, 2012).

To inform our development of the S3 intelligent agent framework, we developed PLACE.web (Physics Learning Across Contexts and Environments) a 13-week high school physics curriculum where students capture examples of physics in the world around them (through pictures, videos, or open narratives), which they explain, tag, and upload to a shared social space. Within this knowledge community, peers are free to respond, debate, and vote on the ideas submitted by their peers. Driven by the KCI Model the goal of PLACE.Web is to create an environment where the class' collective knowledge base is ubiquitously accessible - allowing students to engage with the ideas of their peers spontaneously and across multiple contexts. We will focus on the culminating activity, which occurred across three contexts, employed user contributed materials, leveraged the spatial aspects of the room, and used intelligent agents in a consequential way.

Culminating Smart Classroom Activity

The curriculum culminated in a one-week activity where students solved ill-structured physics problems based on excerpts from Hollywood films. The script for this activity consisted of three phases: (1) at home solving and tagging of physics problems; (2) in-class sorting and consensus; and (3) smart classroom activity.

In the smart classroom, students were heavily scripted and scaffolded to solve a series of ill-structured physics problems using Hollywood movie clips as their domain (i.e., could IronMan Survive a shown fall). Four videos were presented to students, with the room physically mapped into quadrants (one for each video). The activity was broken up into four stages: (1) Principle Tagging; (2) Principle Negotiation and Problem Assignment; (3) Equation Assignment, and Assumption and Variable Development; and (4) Solving and Recording. In each step students moved, or were sorted, within the room completing a set of collective and collaborative tasks that built upon the emerging knowledge base, using their tablets or large format interactive displays. During the acidity the teacher used a set of specially designed feedback technologies to aid in its orchestration.

Orchestration of the culminating script:

Ambient Feedback: A large Smartboard screen at the front of the room (i.e, not one of the 4 Hollywood video stations) provided a persistent, passive representation of the state of individual, small group, and whole class progression through each step of the smart classroom activity. This display showed and dynamically updated all student location assignments within the room, and tracked the timing of each activity, using three color codes (a large color band around the whole board that reflected how much time was remaining): "green" (plenty of time remaining), "yellow" (try to finish up soon), and "red" (you should be finished now).

Scaffolded Inquiry Tools and Materials: In order for students to effectively engage in the activity and with peers, there is a need for specific scaffolding tools and interfaces for students to interact, build consensus, and generate ideas as a knowledge community (i.e., personal tablets, interactive whiteboards). Two tools were provided to students, depending on their place in the script: individual tablets tied to their S3 user accounts; and four large format interactive displays that situated the context (i.e., the Hollywood video), providing location specific aggregates of student work, and served as the primary interface for collaborative negotiation

Real-Time Data Mining and Intelligent Agency: To orchestrate the complex flow of materials and students within the room, a set of intelligent agents were developed. The agents, programmed as active software routines, responded to emergent patterns in the data, making orchestration decisions "on-the-fly," and providing teachers and students with timely information. Three agents in particular were developed: (1) The Sorting agent sorted students into groups and assigned room locations. The sorting was based on emergent patterns during enactment; (2) The Consensus Agent monitored groups requiring consensus to be achieved before progression to the next step; (3) The Bucket Agent coordinated the distribution of materials to ensure all members of a group received an equal but unique set of materials (i.e., problems and equations in Steps 2 & 3).

Locational and Physical Dependencies: Specific inquiry objects and materials could be mapped to the physical space itself (i.e., where different locations could have context specific materials, simulations, or interactions), allowing for unique but interconnected interactions within the smart classroom. Students "logged into" one of four spaces in our room (one for each video), and their actions, such as "flinging" a tag, appeared on that location's collaborative display. Students' location within the room also influenced the materials that were sent to their tablet. In Step 2, students were provided with physics problems based on the tags that had been assigned to their video wall, and in Step 3 they were provided with equations based on their consensus about problems in Step 2.

Teacher Orchestration: The teacher plays a vital role in the enactment of such a complex curriculum. Thus, it is critical to provide him or her with timely information and tools with which to understand the state of the class and properly control the progression of the script. We provided the teacher with an "orchestration tablet" that updated him in real-time on individual groups' progress within each activity. Using his tablet, the teacher also controlled when students were re-sorted – i.e., when the script moved on to the next step. During Step 3, the teacher was alerted on his tablet whenever a group had submitted their work (variables and assumptions)

Analysis and findings from the smart classroom run:

Ambient Feedback: Analysis of the captured video seems to indicate the ambient display was effective for both students and teacher in orchestrating the flow of classroom activities. During the activity the teacher looked at the front ambient display sixteen times. This was often followed by an orchestrational statement, (i.e., telling students to finish up an activity), or an orchestrational move (i.e., advancing the class to the next step). In the post-interview the teacher noted that he would only glance at the display when he wanted a quick update and otherwise ignored it, highlighting the effectiveness of the display for occupying the periphery of awareness until needed. He also noted that the display was very effective in organizing the flow of students and activities as "it let the kids know what group to get to, and it just resolved it quicker to get back to they physics of the moment, I didn't have to spend a lot of time organizing."

Real-time Data Mining and Intelligent Agency: An examination of the server logs showed that the S3 agents effectively managed the distribution of students and materials as per their design. For example, the sorting agents tracked the number of tags assigned to each board by students in Step 1, and regrouped students based on tagging frequency, successfully placing students at new boards with new members in a complex, dynamic re-sorting. The consensus agent also worked as designed, requiring students to reach agreement before moving to the next step and alerting the teacher on his tablet at the end of Step 3 to review group work. The bucket agents also successfully delivered location specific and context-filtered content, providing students with one physics at a time, drawing from a "bucket" of items that were only determined after the principles were settled.

Locational and Physical Dependencies: Both the locational and physical dependencies worked as designed in the intervention. When students logged into a location all their interactions were properly situated within that space. Student contributions and location specific materials were correctly sent between student tablets and the boards and aggregated with the work of others (see agents above). The physical layout of the smart classroom was also proved to be a powerful tool in the enactment of the activity. By placing the interactions around the edge of the classroom not only were videos (contexts) clearly separated, but also the teacher found it useful for orchestrating the activity as placing "the kids on the outskirts" left him "free to wander in the middle."

Teacher Orchestration: The teacher was able to use his orchestration tablet to move the students through all the steps in the activity. Analysis of the video highlighted that the teacher often used the tablet in conjunction with an orchestrational statement, such as instructing the students to watch the ambient display, or to explain what would be happening next (see timeline). In the post-interview the teacher noted that although he found the tablet useful for seeing student progression he actually preferred the ambient and large format displays for this purpose as he found with the tablet he tended to have his head down too much whereas the screens were "large and easily accessible" allowing him to take a read of the class at a glance to decide who to help.

References

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