College Level Active Learning Classrooms: Challenges of using the heterogeneous ecology

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Abstract: At universities and colleges across North American there is growing interest in constructing technology-rich classroom spaces designed to carry out collaborative learning. In particular, various technologies are being used without a clear understanding of the impact they might have on the quality or types of collaborative learning processes. This presentation is a case study of a concrete example of a classroom ecology where heterogeneous technological resources come together and pose special challenges. Specifically, this is a case of two classrooms where students sit in groups of five or six around oval-shaped tables, each with its own dedicated interactive whiteboard (IWB).

Keywords: orchestration, classroom technology, classroom as ecosystem, technology design

Introduction

In the last decade there has been increasing interest in building technology-rich collaborative learning environments that complement constructivist and social constructivist educational paradigms. Examples include the SCALE-UP project at North Carolina State University (Beichner, Saul, Abbott, Morse, Deardorff, Allain, Bonham, Dancy, & Risley, 2007) and the TEAL project at MIT (Dori & Belcher, 2004). Such spaces are generically referred to as active learning classrooms (ALCs).

ALC architecture and furnishings are intentionally designed to shift the focus toward students working together and to reshape the traditional authority structures with the aim of promoting collaboration and collective responsibility for learning. Instead of sitting in traditional desks arranged in rows facing the front, these new spaces feature pod-like clusters where students face each other in small groups. This arrangement reduces – or eliminates – the importance of any single focal point in the classroom and without an obvious teacher-centric "front" to the classroom the learning dynamics can change. Importantly, there is often a sense of democratized access to the teacher who spends more time circulating around the room attending to students as groups and an added sense of increased responsibility on the part of the students to be actively engaged in their own learning.

Most ALC designs also incorporate technologies that are intended to promote visualization, connectivity, artifact creation and sharing. Typically, these designs include networked personal computing devices and projection screens upon which the contents of one or many devices can be displayed around the room. One particular form of classroom technology that has seen limited use in ALC design is interactive whiteboards (IWBs). The potential benefits of this technology, especially when put into the hands of the students, and not reserved solely for the teacher, is that they offer a medium that is the antithesis of the personal computing device – they are shared spaces for the creation and manipulation of collaborative learning artifacts.

In this presentation we report on the concrete examples of two ALCs at Dawson College[1] that feature student dedicated interactive whiteboards. These are new tools in this environment and represent a new learning ecology in which to study the impact of computer supported collaborative learning. The objective of this presentation will be to describe the challenges related to: (1) designing these new spaces; and, (2) monitoring and supporting group collaboration processes.

[1] Dawson College is a large college in Montreal (Canada) that offers 2-year pre-university programs and 3-year

Background

The driving force behind the design of an ALC is the pedagogy. *Active learning* has become a way to describe instruction rooted in constructivist and social constructivist learning theories. Active learning shifts teaching practices away from a transmission of knowledge model to a student-centered model. It focuses on designing for student participation and engagement, and it takes into account the cognitive, social and emotional aspects of learning.

For the post-secondary student, active learning often presents a shift in what is expected. Students are expected to take responsibility for their learning and to engage in the intellectual work required, what might be called "minds-on" tasks and not merely "hands-on." In many cases this involves working collaboratively in groups or as a whole class. Additionally, students are often required to come to class having done required preparation for learning. Lastly, these various activities mean that students often produce knowledge or epistemic artifacts that can be incorporated into the learning ecosystem.

History of these Active Learning Classrooms (ALCs)

The initial development of new ALCs at Dawson College was the result of several key conditions, including: new infrastructure funding dedicated to the college's Science Program; a new cohort of physics faculty that replaced a wave of retiring faculty; and the growing influence of the Physics Education Research (PER) community. Within this context, a handful of faculty began redesigning two out of four dedicated teaching classrooms/labs based on models from MIT (the TEAL labs) and Dickinson College (Pennsylvania). In this first phase of development, the two teaching labs were re-configured from a teacher-centered arrangement with front-facing rows of tables, to a student-centered design with modular hexagonal tables arranged into "pods" where groups of four students sit facing one another and have easy access to desktop computers equipped with an interface for laboratory equipment. The need for modular tables – and the resulting flexible room arrangement - was paramount because these rooms were to be used for everything from lectures to computer based labs, and by a spectrum of teachers who were anywhere from uninterested to very interested in AL pedagogies.

Importantly, these new classrooms reoriented the "front" of the room from its traditional location along the end of the room to the side of the room, and it also featured Interactive WhiteBoards (IWBs) - or SmartBoards™ - for the teacher that could be projected onto screens in the corners of the room. This arrangement allowed for easier movement around the room and allowed any student to see the work being done on the IWBs without turning away from their group to face the front.

Next generation of ALCs

This first generation ALC described above (ALC-V1) provided an opportunity for the research team to collaborate with the physics faculty behind the development of these new spaces. Using an ethnographic approach the researchers documented the practices that emerged through the use of the rooms over a two-year period beginning in the fall of 2009. A purposeful sampling method was used to identify six teachers who best-represented orthogonal approaches to teaching – student-centered vs. teacher-centered and the results are reported in Charles, Lasry and Whittaker (2013). What is important for this current paper were our observations of how both teacher and students used these new spaces and more particularly the IWBs. As one faculty member said: "Once we realized that interactive whiteboards were more powerful *learning tools* when placed in the hands of students than they were *teaching tools* when placed in the hands of teachers, we began to re-think the active learning classroom even further."

The second generation ALC (ALC-V2) was based on the idea of putting Interactive WhiteBoards (IWBs) into the hands of students. More specifically, the design centered on providing a dedicated multi-touch IWB to each student group (Figure 1). This process of integrating the IWB technology into the groups while continuing to promote peer collaboration gave birth to a new table design. The tables started out being circular in shape but in order to bring students closer together and to improve access to the IWBs by students no matter where they were seated, the circles were truncated on two sides. In addition, in order to allow students sitting around these tables to turn towards the IWB without turning away from the group the table was truncated in such a way as to make it wider at one end. This asymmetrical truncated circle (ATC) shape is shown in Figure 1. The room consisted of six ATCs that each seated six to seven students (class capacity = 42) with the wide end of the ATC facing the IWB on the wall. Note that students do not sit along the wide end of the ATC.

Figure 1. Picture of Dawson's 2nd generation ALC (ALC-V2).

The third generation ALC at Dawson College (ALC-V3) kept the ATC and IWB design aspects described previously but aimed to make better use of the classroom space and table arrangement. By using a larger classroom and by placing the tables in a "horseshoe" arrangement (see Figure 2) the intention is to create a space that facilitates larger class-as-a-whole activities while also allowing for better mobility within the classroom – including better accessibility to each group by the teacher. Note that in this design there is no effective depth to the room. No group is closer to the back of the room and all are equally in the center. Lastly, the teacher, while being at the physical center of the room is not the center of focus – that remains at the center of each group's table and the IWBs they control.

Figure 2. Pictures and layout of the 3rd generation ALC at Dawson College.

Monitoring and Supporting Group Collaboration

Over the six-year period of this design action research hybrid, we collected classroom observations using ethnographic methods. Specifically, we followed the development of one of the coauthors as he learned how to orchestrate each of these rooms. We provide a brief description of some materials and activities used in the ALCs, and how the modalities of the groups changed over time. In short, we provide a glimpse of the evolution of the orchestrational moves, which in turn changed the ways the students engaged with the materials produced – i.e., the artifacts being constructed.

Trajectory of development of materials and activities

In ALC-V1 the teacher typically designed activities to be solved collaboratively and completed on individual handouts (i.e. paper-based problem worksheets, diagrams, concept maps, etc.). A typical example of such an activity is a worksheet in which students are asked to draw representations of physical phenomena (collisions, wave propagation, free body diagrams etc.) of increasing complexity. The use of such materials meant that the teacher spent much of his time moving from small group to small group. Often this further focused his attention on an individual or sub-group as he reviewed individual artifacts. Figure 3 illustrates a typical scenario and shows the teacher assisting one student while members of the same small group work together and another student from another group waits in the background with a raised hand. With this type of group work it is difficult to orchestrate entire groups or the class as a whole because of the individual artifact, which is difficult to share with others. In brief, this type of room design and orchestration based on collaboration around individually produced artifacts resulted in the following: (1) It was difficult for the teacher to survey the progress of all the groups around the room in a timely fashion; (2) it was difficult for the teacher and other students to assess and interact with the artifacts; and, (3) there were limitations in the level of group collaboration simply because at any given time some of the students were working on an artifact that would be upside down to half of their group, and in all cases it was difficult to have the artifacts seen by other groups at other tables.

Figure 3. Students working on paper artifact in ALC-V1.

In ALC-V2 and V3, the introduction of multi-touch IWBs meant that students had a large, shared space in which to use and generate learning artifacts that were right-side-up for everyone, visible around the room and dynamic (easily modified, edited, changed etc.). Two such artifacts are described briefly in the next paragraph and we will consider them in greater detail during the workshop. In this next-generation environment it was considerably easier for both teacher and students to scan around the room to see the progress of each group and it was easy to interact with groups and artifacts when appropriate. As the teachers became increasingly skilled at managing the affordances of these spaces, the way in which they created, scaffolded and orchestrated active learning scripts evolved, as did the way students used the technologies to create knowledge artifacts. Initially, students sat around the tables and used the keyboard and mouse to create and interact with the drawings and inscriptions on the IWBs. As teachers encouraged students to get up and use the touch-based features of the IWBs it was noted that there was something different in the way students reacted to the obvious physical gestures entailed when using the boards. Furthermore, new practices evolved as students engaged with each other, the artifacts created and with the technology of the IWBs.

Modalities of Student Engagement

From our observations of ALC-V2 and v3 we have identified three different patterns of engagement in these environments: (1) "tutor/tutee" mode; (2) "executive/directive" mode; and, finally (3) "true collaboration" mode. In the "tutor/tutee" mode, the student at the board would assume the role of either a tutor or tutee. In the case of a tutor mode, the student at the IWB would lead the group in the discourse of knowledge sharing, not dissimilar from that of a tutor showing others how to do the assigned task. In the tutee mode, the student at the IWB would receive directions from the group on what to do much like a tutee would be guided and coached by a tutor. In Figure 4 two variations of the tutor-tutee mode are illustrated by students working on separate physics activities: (1) on the left, students are working at assembling free body diagrams through a heavily scaffolded activity that provides pre-defined vectors, symbols and a reference frame; and, (2) on the right, students are drawing *phasor* diagrams for a simple harmonic oscillator in an activity that is free of scaffolding. In both cases, students are clearly gesturing towards the IWB while directing, supporting or explaining the work being done. Working with the scaffolded vector diagrams appears to support not only the enactment of the activity but it also allows the tutee to have a certain level of proficiency while developing the required skill(s). In a way, it could be said to give the student confidence to be tutored by her peer. It also provided the tutor the ability to point out the fine adjustments, which were immediately recognized by the tutee.

Figure 4. Students using IWBs in ALC-V2 in "tutor/tutee" mode.

In the "executive/directive" mode, the group would typically sit back, using the table as a conference space and generally using the keyboard to enter information on the IWB. Seldom would the students get up and use the pens to write directly on the board; when they did, it was generally under direction from others seated at the table. In this mode, the group didn't tend to interact with the production of the artifact and in fact left it up to the student at the board to be the one doing the work. Generally, students sitting at the table in this mode stayed at the table and did little to interact (manipulate) with the artifact. Instead, they acted as evaluators or give direction rather than acting as collaborative partners. In Figure 5, the executive/directive mode is illustrated as the students are working on a static simple harmonic oscillator worksheet. In this case, the teacher is showing a student at the IWB a correction to the work being done and while the students at the table are attentive and focused, there is none of the gesturing shown in Figure 6 and little evidence of interactive collaboration.

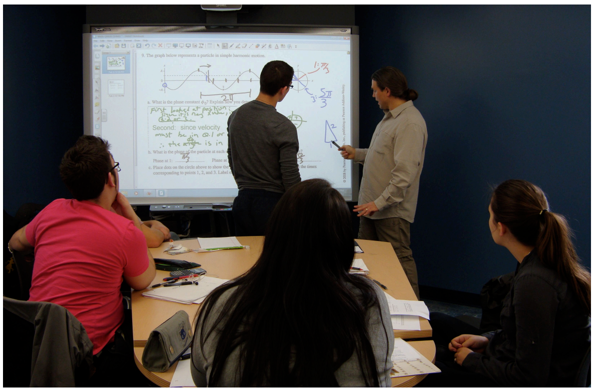

Figure 5. The ALC-V2 in executive/directive mode in which the teacher is giving direction and correcting the work done on the IWB.

In the "true collaboration" mode the teacher encouraged students to get up *en-masse* and use the IWBs and a much more collaborative and dynamic collaboration was observed. In this mode, four, five or six students would all work together while standing up at the IWB. They would point, talk, move, write and contribute to the learning artifact in a seamless way. In this mode students were also observed creating temporary inscriptions and drawings (knowledge artifacts) to mediate their efforts to communicate and construct their thoughts. These temporary personal artifacts would allow them to explain their understanding and elaborate on a communication breakdown. Once resolved, the temporary personal artifact would be erased (or the file would be closed) allowing for the larger shared artifact to continue. In essence, these small moves to a personal, but public space, informed the broader permanent artifacts. This mode is nicely illustrated in Figure 6 below in which students were asked to rotate around the room in groups to assess the solutions to standard kinematics problems done by other groups. In each case, student groups were asked to provide written feedback on the solutions done by another group before returning to their own IWB to review the feedback and continue working on their original problem. In this mode, having the students up at the board facilitated the rotation around the room and the multi-touch IWBs allowed for several group members to interact with the artifacts simultaneously. Additionally, in this mode, the networking options provided by the IWBs, provided the teacher with tools – like "freezing" all boards and asking students to turn their "eyes to (the) front" of the classroom – which greatly facilitated the orchestration process. These will be discussed in detail during the workshop.

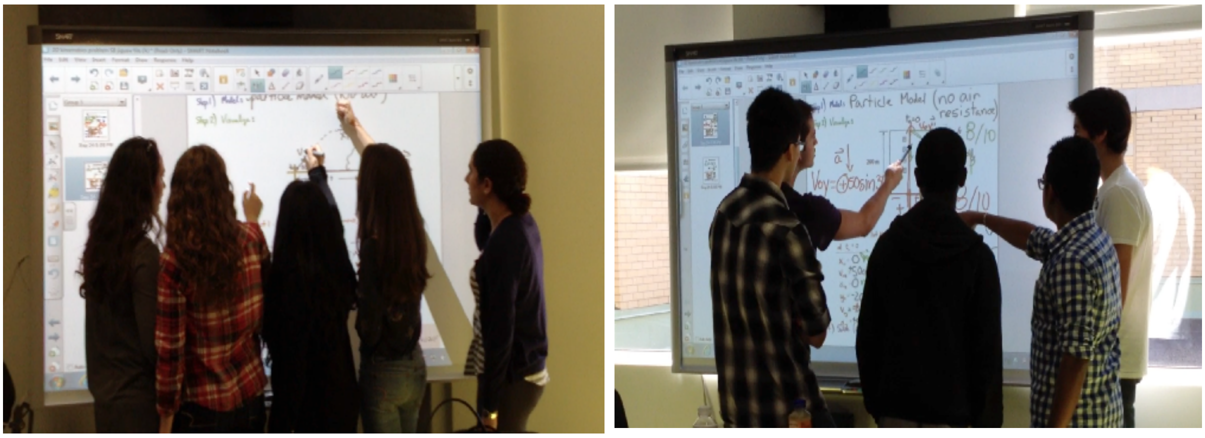

Figure 6. Students using IWB's in ALC-V3 in true collaborative modes

Conclusions

The evolution of ALCs and how they are used has shown us the importance of the technologies (the IWB and the tables), but more importantly, it has shown us the importance of the interplay between the affordances of the technologies and the orchestration of engagement. We are still in the process of analyzing and extracting the lessons learned from this experience and on design and pedagogical issues that still need refinement. Additionally, while we have gained great insight into how to monitor and support group collaboration there is still a lot to learn about the impact of various types of orchestration within these spaces. In particular, how the transition between activities should be paced, and how pacing may or may not be impacted by the types of activities selected, what might be called the pacing of the orchestration, are of interest. Also on the topic of orchestration, our current research is focused on the challenges of how to better design and use learning artifacts that can be transported into and out of the classroom with greater coherence to the objectives of the active learning pedagogy. In the workshop we will review and elaborate on the ideas described and we will explore possible research questions to follow up on.

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