Educational Advances in Artificial Intelligence

■ *The Educational Advances in Artificial Intelligence column discusses and shares innovative educational approaches that teach or leverage AI and its many subfields at all levels of education (K-12, undergraduate, and graduate levels).*

Marie desJardins

ACTIVE-ating Artificial Intelligence: Integrating Active Learning in an Introductory Course

■ *This column describes my experience with using a new classroom space (the ACTIVE Center), which was designed to facilitate group-based active learning and problem solving, to teach an introductory artificial intelligence course. By restructuring the course into a format that was roughly half lecture and half small-group problem solving, I was able to significantly increase student engagement, their understanding and retention of difficult concepts, and my own enjoyment in teaching the class.*

In spring 2013, several colleagues and I received an award, from the Hrabowski Fund for Innovation[1] at the University of Maryland Baltimore County, to create a new classroom, using additional funding donated by BAE Systems and Northrup Grumman. The ACTIVE Center[2] is designed to provide a dynamic physical and virtual environment that supports active, collaborative learning; skill mastery through in-class problem solving; and laptop-based in-class laboratory activities. The ACTIVE Center's design was based on research on the power of collaborative learning to promote student success and retention, particularly for women, underrepresented minorities, and transfer students, who benefit greatly from building stronger connections with their peers through shared active learning experiences (Zhao, Carini, and Kuh 2006; Rypisi, Malcolm, and Kim 2009; Kahveci, Southerland, and Gilmer 2006).

The ACTIVE Center, a 40-student classroom, includes movable furniture (20 trapezoidal tables and 40 lightweight rolling chairs) that is typically grouped into 10 hexagonal table clusters but that can also be arranged into lecture-style rows, a boardroom or seminar-style rectangular layout, or individual pair-activity tables. The room also has an Epson Brightlink "smart projector" at the front of the room, four flat-panel displays (which can be driven centrally by the instructor's laptop or individually through HDMI ports), and 10 rolling 4 x 6 foot whiteboards for use during group problem-solving activities, as well as smaller, portable tabletop whiteboards. The ACTIVE Center was ready for use in early February 2014, and we moved several classes from regular classrooms into the new space, including my undergraduate introduction to AI (CMSC 471).

Over the last 12 years of teaching introductory AI, I had gradually moved toward incorporating more problems and

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exercises into my lecture slides and making the class very interactive. However, I was never completely successful at convincing students to work independently on problem solving during the class — many students would get stuck or distracted, and it was difficult to diagnose their level of understanding. This semester, with a physical environment that was designed to facilitate in-class problem solving, I decided to take full advantage of it, setting a goal of a roughly equal mix of lecture and problem solving.

I created a prereading assignment for each class day that included a short introduction to the basic concepts. I often led off the lecture part of the class with a *mini-quiz* (a slide with questions that students ought to know the answers to from the reading) and a very quick recap of those basic concepts. (Previously, I had never successfully convinced students to do the textbook reading of Russell and Norvig's *Artificial Intelligence: A Modern Approach* [2010] before class. Now, most students, but not all, did this prereading.) I'd then dive into the more advanced material that wasn't covered in the prereading, spending around half of the class on lecture and board-based problem solving (taking advantage of the smart projector to do screen captures of group solutions), and the rest of the 75-minute class period having small groups of four or five students working on more challenging problems.

During problem-solving sessions, students would bring one of the wheeled whiteboards to their table and work on an assigned problem. Once the students got used to the format, they didn't need any urging to get started on their work. I didn't assign the groups (they evolved naturally based on where the students chose to sit) or roles (some groups rotated roles, and in others, it was almost always the same person at the whiteboard). But as I circulated, it was obvious that every single student in the class was engaged with the process — paying attention, contributing, and thinking. It was actually quite remarkable — in a class of 40 students, there was literally not one single person who wasn't involved in problem solving during those parts of the class. Moreover, I could tell which groups understood the concepts and were making progress and which groups weren't. I could work individually with groups who were stuck, and I could identify errors that multiple groups were making, bringing the class's attention back to talk about those misconceptions with the whole class. It was an extremely effective way to mix coaching, remediation, and discussion.

The format did vary somewhat, including days where lectures predominated; where lectures and problem solving were interspersed; or "Lisp labs," where students used their laptops to work on Lisp coding with some instructor guidance. We also rearranged the room into a seminar style layout for a class debate on Searle's "Minds, Brains, and Programs" (1980) and Raymond Kurzweil's theories about the singularity.

I collected assessment data through student and instructor surveys (in all classes offered in the ACTIVE Center), but have not yet systematically analyzed the data. I did not see a significant difference in exam grades or overall course grades compared to my 2011 offering, but my anecdotal observation is that the students did better on the problem-solving parts of the exam but less well on the "details of advanced methods" questions. That makes sense: we spent more time on problem solving and less time covering details, and I don't think that students "filled in the gaps" by spending more time on the reading. How to get both deep conceptual learning and broad understanding of different types of methods and techniques is a continual goal for reflection. Some of the other challenges and ideas for the future include managing class pacing when alternating between lecture and problem solving, designing problems of appropriate difficulty, and creating in-class laptop-based activities to explore AI concepts at the implementation level.

All of my course materials (syllabus, schedule, reading and prereading assignments, PowerPoint slides, which include whole-class and group problem-solving activities, and homework assignments) are posted on the course website.[3] Colleagues are welcome to reuse these materials with attribution; I would greatly appreciate any feedback or experience reports that you would be willing to share. Having taught introductory AI eight times, I can say with confidence that despite feeling some pressure about whether the problem-solving format would work well, this semester was the most fun that I've had teaching an AI course. It would be very hard to return to a regular classroom and to a standard lecture-based presentation style. I strongly encourage other institutions to consider creating or retrofitting classrooms using design practices that would facilitate this kind of coursework and learning environment.

Notes

1. See innovationfund.umbc.edu.
2. See active.umbc.edu.
3. See www.csee.umbc.edu/courses/undergraduate/CMSC471/spring14.

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