Artificial Intelligence in Teaching and Learning

Scenario

Many colleges and universities have seen a steep rise in the number of students pursuing interdisciplinary degrees. Increasingly, students seek degrees in, for example, mechanical engineering with a concentration in anthropology, or U.S. history with a minor in biology, or a double major of mathematics and theater. Such formerly unusual combinations have become almost common, and the emergence of myriad paths to cross-disciplinary studies puts new demands on students and advisors to plan degrees that meet curricular requirements from different programs...ideally without stretching a bachelor's degree well beyond four years.

At one institution, an artificial intelligence (AI) system is helping make sense of the options, as well as informing curriculum redesign and connecting to changing expectations from employers and graduate programs. At the university, advising and degree planning has long been handled at the department level, with relatively little cross-pollination between advisors across academic programs. The AI system looks at data from departments across campus and transcripts from degree programs that are in process and complete. It parses job listings from online employment services, building models of skill sets that are in demand for various jobs and careers. It uses requirements from graduate programs to inform its recommendations for students who express an interest in postbaccalaureate study.

By factoring in such a wide array of sources and data, the system is able to provide students and their advisors with highly specific recommendations about a degree plan that matches educational and career goals. It tracks students over time, suggesting changes along the way. With each semester, the system "learns" more about which combinations of courses and specialties work better for different students.

The system also provides dashboards for faculty, showing them student progress and calling attention to interventions that the faculty could undertake, not only for students who might be struggling but also for those who might benefit from additional challenges. Insights gained from the system also feed institutional efforts to redesign curriculum to better accommodate the growing interest in varied, unconventional courses of study.

1 What is it?

The term *artificial intelligence* **(AI) refers to computer systems that undertake tasks usually thought to require human cognitive processes and decision-making capabilities**, such as translating from one language to another or driving a car. In higher education, the principles of AI underlie a range of innovative systems, including analytics, robot writers, virtual experiences, and intelligent tutoring (ITS). Machine learning, deep learning, and the adoption of neural networks in AI herald a broad array of new AI-driven tools that expand the opportunities to support teaching and learning.

2 How does it work?

To exhibit intelligence, computers apply algorithms to find patterns in large amounts of data—a process called **machine learning, which plays a key role in a number of AI applications**. AI systems often incorporate human feedback to help calibrate the system's learning. In one example, an AI system was developed to play the game Go, an ancient game that involves more complexity and options than chess. The system reviewed a pool of Go matches and "learned" how to improve its play using neural networks, eventually beating the human world champion at the game. Neural networks—which are one of several ways AI can work—are software designed to function like a human brain. In a similar way, AI systems can tackle tasks such as tutoring, which involves diagnosis followed by intervention. Diagnosis requires data collection and evaluation, areas in which many AI systems excel. Effective interventions, however, require an examination of the holistic needs of a learner, including those that are nonacademic, such as a loss of confidence or loss of financial aid, and this approach is increasingly handled by AI.

3 Who's doing it?

Many colleges and universities are **developing AI projects that aid teaching and learning**, such as the pilot project First Class at Pennsylvania State University, which provides an immersive environment for student-teacher experimentation. First Class features a virtual K–12 class with six AI students, allowing aspiring teachers to use

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movement, voice, and gestures to interact with and react to the "virtual students" as the latter engage in a variety of behaviors. At Georgia Tech, an AI teaching assistant named Jill Watson provided support for a course in Knowledge-Based Artificial Intelligence (KBAI). During the pilot year, the virtual TA responded to online forum questions in such a manner that many students were unaware they were corresponding with a computer. Researchers in the field are keenly attuned to the public perception of AI and the ethical considerations it raises. The MIT Media Lab and the Berkman Klein Center for Internet and Society at Harvard University are leading one team of scientists who are studying AI and ethics with regard to public interest, applied research, and education.

4 Why is it significant?

One-on-one tutoring can be an extremely powerful mechanism for learning, but of course this model doesn't scale. Artificial intelligence opens the possibility of individual tutoring to students who could never otherwise have access to it. Current AI tools can select appropriate instruction from a variety of options and provide solutions for individual student needs and requirements. AI learning agents have the potential to **function like adaptive learning but at a much more sophisticated and nuanced level**. AI allows faculty and students to do their work more effectively by providing not just tutors but AI assistants for scheduling, interactive immersive simulations, and human-machine partnerships.

5 What are the downsides?

Considerable misunderstanding exists about what AI can and cannot do, resulting in inflated expectations and a risk that **users could assign inappropriate kinds and amounts of authority to AI systems**. Such concerns raise red flags for those concerned about privacy issues and regulatory approval in areas such as law, medicine, and education. For AI developers, one key issue is an emerging lack of transparency among corporate entities that see their AI programming and algorithmic development as intellectual property. This lack of transparency keeps hidden the basis for a system's methods and recommendations, preventing outside observers from verifying what students have learned and whether the system is dispensing good advice. A new AI implementation can offer information that is extraneous or even inaccurate, particularly in the evaluation of large data sets. Transparency allows others to understand the sources of data, the kind of errors to which the system is subject, and the limitations on its value.

6 Where is it going?

AI is not a single technology but the leveraging of multiple technologies that together create a device or construct that accomplishes certain tasks that formerly required human input. The trend of AI will be toward devices and constructs that conform more closely to human behavior as qualities such as **confidence and self-regulation are added to AI algorithms**. Research already under way will result in AI systems that are better able to handle conflicting or false information. The use of AI systems and devices will expand further into routine activities, leading to a growing familiarity with AI's potential and its limitations. Users may come to understand AI as a system that enhances human capabilities in a partnership between humans and machine, leveraging what each does best.

7 What are the implications for teaching and learning?

Artificial intelligence has the potential to benefit learning in several ways. In the classroom, AI bots can respond to student questions as needed, something that may be particularly useful during large lecture courses or MOOCs—or, in fact, in any situation where access to the instructor and teaching assistants is limited or unavailable. Outside class, personal assistants for instructors and students can keep track of meetings, appointments, social activities, and social media streams. AI has the potential to **give every student a computer-simulated personal mentor** or provide better communication between classrooms worldwide by offering translation and cultural context for students in different countries. Lectures may be accompanied or augmented by immersive virtual reality environments populated by AI personalities that offer meaningful illustration or safe opportunities to practice emerging skills. AI-powered grading systems might be used to evaluate student responses to essay questions and provide reliable translations and transcriptions for academic research papers. These technologies may change the face of higher education as they offer new and intriguing ways to present information and engage student interest.