

## Online Pedagogy: Lessons Learned from Teaching an Online Course in Georgia Tech's OMSCS Program

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### Author Biography

Ashok Goel is a Professor in the School of Interactive Computing at Georgia Institute of Technology and the Chief Scientist with Georgia Tech's Center for 21<sup>st</sup> Century Universities. In 2014, he co-developed an online course on Knowledge-Based AI; in 2016, his research laboratory developed Jill Watson, a virtual teaching assistant for answering questions in online classes; and in 2019, he co-edited a volume on *Blended Learning* published by MIT Press. Ashok received Georgia Tech's Class of 1934 Outstanding Innovative Use of Educational Technology Award in 2017; and Association for Advancement of Artificial Intelligence's Outstanding AI Educator Award in 2019.

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### Introduction

The spread of COVID-19 has led to an unprecedented move towards online education across the country and around the world. This raises fundamental questions for online pedagogy: How do we develop a successful online course? How do we prepare high quality educational materials for online classes?

In 2014, my colleague David Joyner and I faced these questions when we developed an online course on Knowledge-Based Artificial Intelligence (KBAI) as part of Georgia Tech's Online Master of Science in Computer Science program (OMSCS; <http://www.omscs.gatech.edu/>). We identified about 150 KBAI concepts, methods and skills we wanted students to learn, developed a set of twenty-six video lessons, and designed a suite of homework assignments, design and programming projects, and take-home examinations (Goel & Joyner 2016, 2017). In Fall 2014, we offered the online class to about 200 students in the OMSCS program. In Fall 2015, I transformed the pedagogy I had been using in the in-person KBAI class for graduate and undergraduate residential students for more than a decade into blended learning (Goel, 2019). In Spring 2016, my Design & Intelligence research laboratory developed a virtual teaching assistant called Jill Watson for automatically answering routine questions in the online class (Goel & Polepeddi, 2017). We estimate that more than 6,000 students have taken the online and blended versions of the KBAI class since Fall 2014 and more than 150 (human) teaching assistants have helped with the teaching and learning in the class.

Assessing the quality of learning in any class is a complex matter, whether the class is online, blended, or in-person. Three types of data indicate that the quality of learning in the online KBAI class is comparable to that in the in-person class for residential students (Goel & Joyner, 2016, 2017; Goel, 2019). First, surveys of online students from Fall 2014 through Fall 2019 report the same kind and degree of satisfaction with the online KBAI class as do the residential students with the in-person KBAI class. Second, the completion ratio in the online KBAI classes during this period has been comparable to that in the in-person KBAI classes. Third, the performance of the online KBAI students on the same set of learning assessments has been comparable to that of the residential students in the in-person KBAI classes. In Fall 2018 and Fall 2019, we repeated the quasi-experimental studies in online and in-person sections of the KBAI class offered only to residential students, and found similar results.

### Design Principles for Online Classes

In Goel & Joyner (2016), we analyzed the design principles for developing online classes in detail. Table 1 summarizes the 10 design principles underlying the online and blended KBAI classes. For example, the first principle suggests that the course instructor should explicitly establish the learning goals, outcomes,

strategies and assessments before developing the online class. The eighth principle indicates that design of an online class is an iterative process, with each iteration based on feedback and reflection on the preceding iteration. Thus, it is important to collect and analyze feedback and leave time for deliberation and reflection.

*Table 6: Design Principles for Online Classes (adapted from Goel & Joyner, 2016)*

1. Establish learning goals, outcomes, strategies, and assessments first
2. Allocate adequate time for design, development, and delivery
3. Deliberately recreate natural features of the residential class
4. Leverage the advantages of digital media for online learning
5. Design project-based learning carefully
6. Understand the audience
7. Break the isolation experienced by many online students
8. Solicit feedback and be ready to iterate
9. Leverage peer feedback and autograding wisely
10. Use the online class to enhance the residential class

### **Design Principles for Video Lessons**

The twenty-six video lessons for the online and blended versions of the KBAI class embed about 150 exercises, one for each concept in the concept inventory, as well as about 100 tutors that provided adaptive feedback on many of the exercises (<https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409>). My colleague Chaohua Ou has analyzed the design of the videos and student responses to them over several semesters (Ou, Joyner & Goel, 2019). Table 2 summarizes the seven principles for designing video lessons for online classes derived from the analysis. For example, the seventh principle suggests the use of prepared visuals rather than drawing them at the time they are being presented to the class.

*Table 7: Design Principles for Video Lessons (adapted from Ou, Joyner & Goel, 2019)*

1. Learning by example
2. Learning by doing
3. Adaptive feedback
4. Learning through reflection
5. Four-phase instruction principle (activation, demonstration, application, integration)
6. Personalization principle (visible instructors, conversational presence, on-screen coaches)
7. Multimedia principle (prepared visuals)

### **Reflections**

We note three qualifications. First, developing a successful online class requires expertise not only in the subject of the course, but also in information technology and learning science. It also requires a strong team, and significant financial and technological support. We were fortunate to have all these assets available when developing the online KBAI class in 2014. For example, Georgia Tech provided financial and technological support for developing the video lessons for the online KBAI class.

Second, if a teacher's goal is simply to convert the educational materials prepared for an in-person class to an online forum due to the spread of COVID-19 and the consequent need for social distancing, then we expect the design principles in Table 1 and Table 2 should be of some value. These principles are likely to add more value if in the longer term a teacher wants to develop a new online course from the start.

Third, learning in general is situated in the external world and thus is context dependent. Hence, the effectiveness and efficiency of learning depends not only on the individual learner, teacher, pedagogy, and educational materials, but also on the physical, technological, social and cultural contexts of learning. While we found the design principles enumerated above useful in developing the online KBAI class, we expect that their operationalization will vary across different learning contexts.

## References

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