The Unexpected Pedagogical Benefits of Making Higher Education Accessible

David Joyner
Udacity, Inc.
2465 Latham Street NW
Mountain View, CA 94040
david.joyner@udacity.com

Georgia Institute of Technology
85 5th Street NW
Atlanta, GA 30332
david.joyner@gatech.edu

Ashok K. Goel
Georgia Institute of Technology
School of Interactive Computing
85 5th Street NW
Atlanta, GA 30332
ashok.goel@cc.gatech.edu

Charles Isbell
Georgia Institute of Technology
School of Computer Science
801 Atlantic Dr. NW
Atlanta, GA 30332
isbell@cc.gatech.edu

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Abstract
Many ongoing efforts in online education aim to increase accessibility through affordability and flexibility, but some critics have noted that pedagogy often suffers during these efforts. In contrast, in the low-cost for-credit Georgia Tech Online Masters of Science in Computer Science (OMSCS) program, we have observed that the features that make the program accessible also lead to pedagogical benefits. In this paper, we discuss the pedagogical benefits, and draw a causal link between those benefits and the factors that increase the program's accessibility.

Author Keywords
Online education; accessibility; higher education.

ACM Classification Keywords
K.3.2. Computer and Information Science Education.

Introduction
Recently, there have been several efforts to make higher education more accessible, with massive open online courses—MOOCs—leading this charge [1]; however, MOOCs have proved to be divisive in higher education, with some educators praising their potential to make educational content accessible [7], while other researchers have noted that MOOCs have not yet delivered on many of their original promises [3, 8].

Tools of the Program

- **Piazza:** The forum and de facto "classroom" for OMSCS classes, for class discussions, questions, announcements, and other virtual analogues of the in-class experience. Every OMSCS course heavily leverages Piazza.
- **Peer Feedback:** A tool developed at Georgia Tech for pairing students for peer reviews. Peer review is used as a learning activity, not to generate grades, although experiments have been performed on using peer review to support expert grading [4]. Roughly one third of the classes in the OMSCS use Peer Feedback.
- **T-Square:** The Sakai-based learning management system used for assignment submission and expert evaluation.
- **Udacity:** The host of the program's prepared lecture material, as well as interactive exercises and some class projects.

In the two years since the Georgia Tech online Masters of Science in Computer Science debuted, we have noted that in some ways, this program has delivered a superior pedagogical experience to the traditional residential program, specifically due to the factors that made the program accessible. Here, we describe and connect that accessibility, to the pedagogical benefits we have observed. We conclude that with the right planning, the relationship between accessibility and pedagogy can be mutualistic, not parasitic.

OMSCS Program

The Georgia Tech OMSCS program was developed through a partnership with AT&T and Udacity, and has since grown to over 3000 students in two years. The experience is similar to residential students: students apply for admission, pay tuition, earn grades, and complete the same assignments, projects, and exams. The chief difference is that class material is delivered via Udacity.com in lieu of classroom lectures.

Each OMSCS class is built around a MOOC developed by Udacity. However, the for-credit offering of the class includes individual instructor involvement, expert human grading, complex projects, and other factors that are uncommon in MOOCs. The courses themselves are similar to distance learning classes, with the MOOC as a textbook. The OMSCS, however, is built from the ground-up to take advantage of the internet; it is remarkably affordable compared to residential and distance learning degrees; it is capable of admitting a greater number of students; and it is an equivalent degree to the residential program. Thus, the OMSCS is large, flexible, affordable, and partially pre-produced like MOOCs, but is also rigorous, accredited, and subject to admissions and tuition like distance learning.

Increased Accessibility

The OMSCS program addresses four traditional barriers to access: scheduling, geography, cost, and exclusivity.

- **Schedule Flexibility.** OMSCS classes require no synchronous activities and present most class materials on the first day of the semester, allowing students to succeed without taking time off work.
- **Geographic Flexibility.** The OMSCS has no residency requirement. Students may succeed without uprooting their family or leaving their job for two years. One student wrote, "I wrote and submitted Assignment 1 from Liberia. Project 1 was coded in Israel, and submitted in Palestine. Assignment 4 was written and submitted from Mongolia. And Project 2, from home in Portland."
- **Economic Affordability.** The program costs approximately $8000 including books and fees. The low tuition and flexibility noted above dramatically reduce the true costs of the program. As a result, a plurality of students enroll in the program not for career benefits, but for personal enjoyment.
- **Enhanced Inclusivity.** The program has no physical barrier to create an artificial student capacity. As a result, while the on-campus program fills up with only 10% of applicants, the OMSCS accepts all qualified students. This creates a much more diverse student body, with backgrounds and experiences from outside computing.

Student Demographics

Table 1 compares the demographic information of the online and residential sections of CS7637 in Fall 2014 [2]. Notably, online students tend to be older, more educated, and more experienced. They are also more likely to be male, domestic, and employed, although

Student Profiles

	Online	Residential
Age		
<24	15%	82%
25-34	47%	17%
>35	39%	1%
Gender		
Female	10%	24%
Male	90%	76%
Location		
Domestic	87%	32%
International	13%	68%
Level of Prior Education		
Bachelor's	87%	94%
Master's	11%	6%
Ph.D.	2%	0%
Employment Status		
Full-Time	90%	5%
Part-Time	5%	15%
None	5%	80%
Prior Coding Experience		
<8 years	45%	90%
9-18 years	41%	10%
>18 years	14%	0%

Table 1: Comparison of online and residential students in the KBAI class in Fall 2014.

the different gender ratios are due to the drastically different international and domestic ratios between the programs. Within each location, the gender ratios are the same between the online and residential programs.

Pedagogical Benefits

The accessibility of the program has led to a student population that is more intrinsically motivated to learn, more experienced, and more professionally diverse. We argue this unique student body and the structure of the OMSCS combine to create unique pedagogical benefits.

Student-Initiated Discussions

In traditional residential classes, time is a finite resource that must be budgeted carefully. Online, there does not exist a finite amount of synchronous class time to budget, and thus student-initiated discussions do not compete with planned activities. In CS6460 in Fall 2015, for example, the class concluded with over 500 discussions initiated by students.

Parallel Discussions

In residential classes, students must take turns and the class (or groups within the class) may only discuss one topic at a time. This makes individualization difficult: a particular discussion may confuse the low-achieving students or bore the high-achieving students. Online, discussions may proceed in parallel, allowing students to self-select which discussions are appropriate for their ability. This also allows the volume of discussion to expand; in CS6460 in Fall 2015, ~100 students and instructors generated 11,000 posts in 17 weeks.

Extended and Self-Documenting Discussions

Because discussions in residential classrooms are time-boxed within the assigned class time and conducted verbally, the discussion must end with little left behind except students' notes and memories. Online, discussions have no need to come to an artificial end, and all discussions inherently self-document. In CS6460, for example, class projects are captured in single long-running threads that document the project team's progress across the entire semester.

Help-Seeking and Student-to-Student Interactions

In the OMSCS, students ask any questions on Piazza. While the question may be implicitly targeted to the instructor, students may enter and answer or follow-up. Thus, student-to-student interaction dominates the class experience. As a result, students receive rapid answers and feedback from that diverse and experienced student body instead of just instructors. The average time to receive an answer is 30 minutes.

De Facto Teaching Assistants

With most classes enrolling anywhere from 200 to 500 students, there are reliably certain students who are excessively helpful. To an outside observer, these students would appear to be teaching assistants with the extent to which they help their classmates. Anecdotally, it is not unusual for students to note that certain classmates dramatically improved their class experience. This has also allowed instructors to identify candidates for future teaching assistant positions.

Expert-Level Peer Feedback

As noted previously, many OMSCS use peer review [4] to allow students to review classmates' assignments. Although MOOCs often use peer feedback to generate assignment grades [6], the OMSCS program instead leverages the known pedagogical benefits of both giving and receiving peer review [5]. The unique

student body present in the OMSCS means that experts are participating as peers in these exercises as well.

Organic Student-Instructor Interaction
As instructors, we have been struck with how the online forum structure creates a 24-hour classroom where we may come, view discussions in their entirety, and participate in every conversation, with everyone able to listen. This has led to the most common positive feedback we have received: students have commented that the student-instructor interaction in these classes exceeds any residential class they have taken.

Conclusion

In this paper, we have worked as participant-observers, noting pedagogical benefits to students in the OMSCS program not previously seen in residential classes. OMSCS students agree: in Summer 2015, 90% of online CS7637 students rated the course as better than residential courses. CS6460, a course that relies on the benefits outlined above, drew a similar assessment; 80% rated it as better than other courses. Students frequently praise the teaching teams' involvement, the chance to review classmates' work, and the active student communities, all of which come from efforts to increase accessibility. With the right circumstances and planning, the relationship between accessibility and pedagogy can be mutualistic, not parasitic.

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