

# **The Impacts of Online Learning in Higher Education**

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree  
Bachelor of Science, School of Engineering

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Spring, 2020

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## **Introduction**

At the time of publication, the world is experiencing a global pandemic at the hands of the novel coronavirus. In an unprecedented move, colleges and universities across the country have moved classes online for the remainder of the academic year. While this time period is without a doubt chaotic, it presents a unique opportunity for universities to experiment with various online learning tools and evaluate their impact on the student experience. The coming months offer a chance to reflect on how higher education is organized on a broader scale.

Historically, elite colleges and universities have been resistant to moving large portions of their offerings online despite their potential benefits and the relative success of online learning pioneers such as the University of Phoenix, which claimed a peak enrollment of more than 470,000 students in 2010 (McKenzie, 2018). While it's too early to tell whether a partial semester of forced and unplanned online classes will substantially shift the perception of online learning in general amongst elite colleges and universities, there are many unanswered questions on the minds of those within higher education. How effective are online learning tools in comparison to traditional teaching methods? How do students perceive online instruction? How does the role of a professor change? As the situation develops, higher education systems will consider these and many other questions as it looks towards online learning in the fallout of the coronavirus pandemic.

The goal of this paper is to describe the impact of online learning in higher education in the United States, taking into account both a historical perspective and how that perspective may be changing due to the novel coronavirus. In this analysis, I will first provide context regarding the state of higher education and what role online learning plays. I will use Social Construction of Technology (SCOT) to discuss the adoption of these technologies across higher education by considering their adoption amongst for-profit schools, community colleges, and traditional universities. Then, I will use the Actor-Network Theory (ANT) framework to explore how online learning tools are critical actors which substantially

impact higher education. I will consider the various impacts that these technologies have on higher education and its stakeholders, including students, instructors, and administrators.

### **Background**

Online tools help instructors manage their courses by providing administrative features such as managing roster and grade information, at minimum, and often an assortment of other features - delivering instructional content, managing office hours, and providing feedback through auto-grading - which are critical to the student experience.

There is an important distinction between online learning in the broad sense and online course management and tools in a narrow sense. Online learning is a more general term, referring to classes offered beyond the traditional context of a classroom. They are provided through online course tools which facilitate the standard interactions that would traditionally happen in a classroom such as course administration, grading, content delivery, and feedback, among other things. These concepts are distinct, but very clearly intertwined.

### **History and Adoption - SCOT**

“A learning management system (LMS) is a software application for the administration, documentation, tracking, reporting, and delivery of educational courses, training programs, or learning and development programs” (Ellis, 2009). The first software LMS was built in the 1990s, and today there are several LMSs offering a wide range of services. Online learning tools are a standard part of the modern classroom. Canvas, the world’s fastest-growing online learning management system, has over 30 million users across the globe (About Canvas). Virtually all modern universities use some form of online course management software, and most classes supplement traditional lectures and labs with a course tools website through which a great deal of a student’s interactions with the course occur.

The SCOT framework holds that “theories do not succeed because they are ‘true,’ but rather because they are socially supported” (SCOT). There are many factors which go into the adoption of various tools. I will look at this adoption at two levels: online learning in general, then more specific learning tools. I will discuss how changing enrollment numbers impact the adoption of tools and speculate how the ongoing coronavirus pandemic will impact higher education moving forward.

In virtually all forms of higher education, there is a perceived tradeoff between the cost of education and the value of the student experience. From their inception, the promise of online learning platforms has been to reduce per-student costs of education by offering classes at scale without significantly impacting the student experience. Online classes were jumped at by for-profit universities such as the University of Phoenix, which launched its online program in 1989 (University of Phoenix), who benefited from low fixed costs to achieve lucrative profit margins so long as they could maintain high enrollments. Community colleges soon followed suit and now offer a wide array of online classes to their students. For these institutions, the math of the cost-benefit analysis of online classes made sense. Online classes could be offered more cheaply and with more flexibility, allowing students to enroll who would be unable to afford college otherwise. These institutions are listening to the research which suggests that “there is robust evidence to suggest online learning is generally at least as effective as the traditional format” (Nguyen, 2015).

Meanwhile, elite colleges and universities still view traditional classrooms as an irreplaceable part of the student experience. These schools have been resistant to moving large portions of their offerings online despite the clear potential for cost savings. As a recent New York Times opinion piece writes, “[e]lite colleges and universities [take] advantage of commercial tools for delivering readings and assignments and taking attendance, but generally [continue] with sage-on-the-stage, small seminar discussions or other conventional delivery models for their core operations” (Arum, R., & Stevens, M. L., 2020). Some research suggests they may be right, as the increased class sizes made possible through

online learning come with their own set of concerns for students. A Binghamton University study found that increased class sizes caused not only a decrease in student performance, but also drops in student retention, as well (Keil & Partell). Another study, focused specifically on introductory level computer science classes, found that smaller class sizes increased student satisfaction and provided more benefit to students in traditionally underrepresented groups in addition to echoing similar increases in student performance and retention (Boyer et. al., 2011).

The core promise of online learning tools is their ability to enable larger class sizes by delivering content, feedback, and assessment at scale, while maintaining a high quality learning experience for students. Larger class sizes allow for increased enrollments, bringing revenues up on a per-professor basis. While it's difficult to say exactly where that money is going, increasing enrollments by moving portions of classes online is a promising option for many financially struggling universities trying to stay afloat without overburdening their students through increasingly higher tuition. University administrators and professors are grappling with the tough decisions of whether and how to increase the online presence of their classes. Finding the right balance between increasing access and affordability of education while maintaining a high standard for the student experience can be tricky.

A noteworthy observation in the online learning space is its seemingly paradoxical ability to reach new audiences by providing education at a lower cost and a more flexible schedule while simultaneously decreasing student retention. This tradeoff is no doubt an important factor in the decision making processes of institutions considering offering online instruction. College enrollment in the US has declined for eight consecutive years (Fain, 2019), leading smaller colleges, community colleges, and for-profit universities towards the online space in order to attract new students. Meanwhile, traditional universities are banking on in-person instruction yielding better retention rates despite higher costs. Many schools are struggling to retain students. The innumerable lawsuits regarding recruiting practices at for-profit institutions (Shireman, 2017) is evidence of this theory and shows just how out of hand this

dynamic can become. The subsequent tarnishing of the reputations of for-profit schools, and to a lesser degree, through close association, online education as a whole, merely contributes to the perception that a traditional education is indisputably the best option. It's clear that while online learning provides some benefits over traditional in-person classes, how these advantages have been exploited have negatively impacted the adoption of these tools.

However, the coronavirus pandemic is offering an interesting opportunity of reflection for the nation's universities and a chance to re-evaluate their stance on online learning. If the experience is generally perceived positively, university administrators may be quick to jump on the online learning bandwagon and its corresponding cost and logistical savings. To some institutions, especially those struggling financially who were considering or planning to move online in the near future, this semester is a natural transition to how operations may continue moving forward. If the online experience is received negatively, it will further convince traditional institutions that there's nothing quite like a chalkboard and a foldable writing tablet.

Evidently, what may end up mattering more than the institutions' perceptions is the perceptions of the American public. This is an opportunity for millions of American students to experiment with fully online learning and reflect on the value of the education they're paying for. As one Barnard student recently put it, we're "watching the entire ivy league slowly turn into the university of phoenix" (onaroo, 2020). Wide acceptance of online learning as a legitimate alternative to the traditional four-year college experience would put pressure on elite universities to adapt by lowering their costs, while wholesale rejection of online learning could widen the gap between the various styles of institutions. While any sweeping, unanimous changes to public perception are unlikely, any shift in the public perception of online learning will ultimately put pressure on schools which are already struggling with tighter margins amid decreasing enrollments (Krantz, 2018).

Consider a university aiming to satisfy increased enrollment by looking towards online course tools to continue to provide a quality experience to students. The first thing to notice is that this becomes complicated to evaluate from the administrative level as the needs of various fields of study are considered. For example, the issue of increasing enrollments is very pertinent to the field of computer science, which has seen “phenomenal growth” in both the number of students majoring in the field and the number of non-majors and minors electing to enroll in computer sciences courses since 2006 (CRA, 2017). The nature of computer science itself makes it low hanging fruit for the introduction of online tools, since objective course work lends itself towards automation more easily than subjective course work. It is much easier to, say, develop a tool which collects and provides automatic feedback for programming assignments than it is to do the same for assignments in an art class. It is clear that some fields of study are more natural candidates to move online than others. Later, I will discuss in more detail the features that online tools provide and their impacts on the student learning experience.

Once an instructor has identified that they want to use online tools to enhance their course, where do they look? Oftentimes, the answer is to build a solution “in house”. This is especially true in computer science, where university professors with software development skills would rather build a solution that fits their specific needs than adapt their course to existing software. As the paper *Automated assessment tools: too many cooks, not enough collaboration*, whose title quite succinctly identifies the issue, points out, “[r]esearchers have been creating tools for decades, but often in isolation” (Pettit & Prather, 2017). The result is umpteen competing, disjointed options offered from both academia and private industry. This muddies the decision making process for professors and institutions aiming to provide the best experience for their students, since “researchers may have a difficult time synthesizing valid data to draw conclusions about the tools' efficacy for increasing student learning”. While SCOT is traditionally used to look at how technologies succeed because they are socially supported, course tools are an interesting case where

demand for the technology is high, but social support is murky in part because of how disjointed the various tools are.

### **Network Analysis - ANT**

The proliferation of supplementary online learning tools begs the question of how exactly these tools impact society. Actor-Network Theory (ANT) affords a useful framework to analyze these impacts. A core concept from ANT is the agency of non-humans in an otherwise human-centric network (ANT). In this analysis, I will look at how online learning technology is a key component to the modern education system, paying special attention to the far-reaching impacts of non-human agents such as autonomous grading and feedback, cheating detection systems, and system interfaces/applications.

#### *Grading*

Automated assessment tools (AATs) have become ubiquitous tools in computer science courses in an attempt for professors to keep up with increasing enrollment. But what are the impacts of these tools on the role of the students and professors? One paper, titled *Are Automated Assessment Tools Helpful in Programming Courses?*, found an “[o]verwhelmingly... positive impact on student learning with the introduction of an AAT into a course” (Pettit, et. al., 2015).

An important impact of automated grading is its role in the shifting of responsibilities of the professor. “At issue is the basic job description of a professor” (Young, 1997). A simple but important realization is that “[a]utomated grading is a vital tool in providing quality assessment of student programs as enrollments increase” (Edwards, 2008). Automated grading is asynchronous, breaking the standard dynamic that larger class sizes would require more time spent by the instructor on grading. Online learning technologies vary widely in scope, ranging in extremes from simple course gradebook management to fully autonomous educational systems that exist without the need for a human professor.



Where the lines are drawn contributes a great deal towards the role of the instructor. The common case within computer science education is that automated grading is leveraged to reduce the time instructors spend grading students, with that hopes that “[b]y automating the process of assessing program behavior, TAs and instructors can spend their grading effort on assessing design, style, and documentation issues” (Edwards, 2008). Previously referenced research by Pettit mentions that “instructors appreciate AATs for the benefits they provide, such as the time savings... [T]hese tools are effective time-savers and are proficient at the tasks they are designed to perform.” The paper goes on to describe further benefits of automated grading of programming assignments, “including reduced grading bias and increased grading consistency” (Pettit, et. al., 2015).

### *Feedback*

A large part of AAT’s success is their ability to provide feedback, which “plays an important role in the student learning process as it gives the learners greater insight into what they have actually done to arrive at an outcome” (Alharbi, 2017). While it may seem that online course tools serve as an impediment to feedback by providing an extra layer between instructors and students, a study from Price & Petre (1997) showed that “the nature and quality of feedback are comparable on paper and electronic assignments.” The same study noted that this may be due in part to the fact that “electronic assignment handling makes everyone’s handwriting better.” For computer science classes in particular, where grading scripts can compile and run student submissions immediately upon receiving the submission, automated grading also allows for nearly instant turnaround time on feedback. Web-CAT, a well-known open-source automated grading system which is known for grading students in part based on how well they test their own code, explains the added value to students that feedback from near-immediate automated grading provides: “instructors usually allow multiple submissions for a given program. This allows a student to

receive immediate feedback on the performance of his or her program, and then have an opportunity to make corrections and resubmit before the due deadline” (Edwards, 2008).

While it’s clear that the availability and quality of feedback is important, there is uncertainty about exactly how much feedback is optimal for learning. Modern programmers receive feedback at the most foundational level: within the medium with which they write code. Integrated development environments provide features such as real time syntax highlighting, the programmer’s equivalent of spell check. While some research suggests that syntax highlighting does not improve novices’ ability to comprehend code (Hannebauer, et. al., 2018), other research suggests that syntax highlighting significantly improves task completion time, with stronger effects among programming novices (Sarkar, 2015). The next opportunity for feedback is at code compilation, where researchers have created clever tools which display enhanced compiler error messages with the goals of providing more approachable and understandable feedback. One such study concluded that “despite anecdotal stories, student survey responses, and instructor opinions testifying to the tool’s helpfulness—enhancing compiler error messages shows no measurable benefit to students” (Pettit, Homer, & Gee, 2017).

An interesting observation of the work of Pettit and others is a seeming disconnect between what the students perceive to be helpful and what data suggests is actually helping them learn. As mentioned above, fine-grained tools such as syntax highlighting and compiler error messages are viewed positively by students while providing no measurable benefit to their learning. Meanwhile, as previously mentioned, AATs show clear, measurable benefits to the learning of students. However, studies analyzing the perceptions of these tools among students claim there is “insufficient evidence to show that students found that AATs have helped them,” with opinions ranging from an appreciation for the constantly available and quick feedback to complaints that the AATs were too “picky” and failed to pick up on simple errors that humans would easily recognize (Pettit, et. al., 2015). This pattern of disconnect between

what students think is helpful and what is actually helpful is further evidenced by the existence of the following section.

### *Cheating*

While automated grading may help courses scale as enrollment increases, taking humans completely out of the loop means that cheating must be handled in an automated fashion, as well. Cheating detection systems such as MOSS can help detect plagiarism in programming assignments in the case where students share code with each other, but these systems, by their own admission, still have flaws (Boyer & Hall, 1999). Automated cheating detection systems introduce an interesting variable in the relationship between students and professors. Traditionally, students aiming to cheat merely have to fool the professor. However, the introduction of automated cheating systems means that most professors will not take the time to check a student's submission unless the cheating detection system raises a red flag on the submission. If a student is trying to cheat, they can focus on beating the automated cheating detection system rather than the professor. Despite the prevalence of what most professors consider to be quality cheating detection systems, this shift in mindset from fooling a professor to fooling a software program may be among the reasons why cheating is such a pervasive problem, especially in introductory-level computer science classes. The New York Times published an article in 2017 describing how cheating has increased in conjunction with increased class sizes. In the fall 2017 semester of Harvard's introductory computer science class, more than 60 out of 655 enrolled students were referred to Harvard's honor council on allegations of academic dishonesty. Stanford has seen similarly egregious honor violations in its introductory computing class, as well as in upper level courses. In a recent offering of the machine learning course, there was an incident involving "far too many [honor code violations] to report [to the Office of Community Standards]" (Park, 2019).

## *User Experience*

Another area to explore is the user experience of these technologies. Given that more and more of the student experience is defined through students' interactions with these course tools, the user experience these tools provide can have a significant impact on students' perceptions of the university experience as a whole. A study at The University of Newcastle looked into the percentage of students who were aware of various university services. They found that Information Technology Services such as myHubOnline, the online student gateway to their own enrollment information, was the most well-known service the university provided, beating out services providing information about graduate study, scholarships, sports facilities, and even food outlets (Morahan, McConkey, & Young). Improving the student experience is among the chief concerns of the university administration, especially with the increasing role of students as consumers (Green, et. al., 1994). As online education continues to expand, user experience could serve an increasingly important role in where students put their dollars, and, subsequently, where administrators allocate their schools' funds.

## **Conclusion**

Technology is expanding the concept of what a classroom can be and inspiring the questioning of perceptions of how higher education should look. The ongoing coronavirus pandemic is subjecting millions of students to a hands-on experiment which should provoke reflections on the value they're getting for their education. As the landscape of higher education continues to evolve, online learning and online learning tools will no doubt be an important part of that evolution due to the scalability and profitability of these systems and the value they can provide to the student experience. These technologies fill a wide variety of roles and are critical actors in the modern university.

The methods and tools of education will continue to change over time, driven by a number of factors. The SCOT framework implies the warning that societal factors may lead to dominant suboptimal

technologies. Many of these factors are non-human actors, as explained by ANT. But let us not forget the most important factor: learning. In a book review of *Teaching with Technology: Creating Student-Centered Classrooms* (Sandholtz, Ringstaff, & Dwyer, 1997), a book based on a study “investigat[ing] how the routine use of technology by teachers and students would affect teaching and learning”, Jennifer Handley states plainly that “[t]echnology has the potential to change education in beneficial ways, but only under certain circumstances... the operating principle of the study was not for the teachers to use technology all the time, but to use the tool that best supported the learning objective.”

Words: 3671

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