EARLY ADOPTERS OF OER:
INSTRUCTOR ADOPTION PATTERNS FOR AN OPEN SOURCE
DATA ANALYTICS CURRICULUM

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Abstract

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This study examined an initiative at the researcher’s institution to provide an online, open source data analytics curriculum for courses at the university level. Semistructured interviews were conducted with seven professors of accounting at universities in the US and Canada to explore their experiences while adopting this open educational resource to teach data analytics skills and tools. Transcripts were analyzed using Interpretive Phenomenological Analysis (IPA) to identify themes. Three major themes emerged from the analysis: instructor responses to a changing professional field for which they were preparing students; adapting approaches to instruction to meet changing demand; and navigating the university’s institutional environment and the marketplace of data analytics tool providers to promote diffusion of new teaching practices. These findings were considered within the context of existing literature on education technology and Diffusion of Innovations Theory (IDT) to identify opportunities for next practices and to support adoption across departments and institutions. Findings of this study suggested formalizing market research to better understand workplace demands, identifying early adopters of next practices and elevating their work, tying academic innovation to education research, and deploying existing administrative personnel to support technology adoption.
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Chapter One: Introduction to the Study

This study sought to examine an initiative at the researcher’s institution to provide an online, open source data analytics curriculum for courses at the university level. It explored the experiences of instructors, acting as early adopters, to teach data analytics skills and tools to university students. Upon registration on the website, an instructor can gain access to a dynamic, anonymized data set drawn from a large company, as well as tutorials, cases, and assistance in obtaining licenses for data analytics tools such as Tableau and IDEA. The purpose of this interpretive phenomenological study was to understand the decision-making processes of instructors adopting an open source technology tool, and what rationales and motivations drove this decision to adopt. Likewise, it sought to understand what impact this decision to adopt had on the instructors’ peers.

Context and Background

As digital technology has played a greater role in higher education, universities have poured institutional resources into the development of online courses—investing in instructional design and IT support staff, faculty development programs and digital teaching tools. This has been done under the presumption that innovation in instruction and delivery methods can expand access to higher education, lower its cost, and provide a pipeline of enrollment beyond the residential experience. In graduate-level and professional degree programs, change in this direction has been particularly robust. As an integral part of the process, faculty members must have some motivation and interest in developing digital course materials for students to succeed.

According to an annual survey by the Babson Survey Research Group, more than 70 percent of chief academic officers at higher education institutions agreed that online education was critical to their institution’s long-term strategy, which was an all-time high (Allen and
Seaman, 2015). Meanwhile, Inside Higher Ed’s (2017) annual survey of faculty attitudes on online learning found that faculty are consistently skeptical of online learning and the motivations behind it. About half disagree with the notion that online learning can achieve learning outcomes equivalent to face-to-face courses, whereas a large majority of technology administrators hold the opposite view. More encouragingly, a significant majority of faculty who have taught online say that the experience helped them develop skills that improved their teaching both face-to-face and online. And nearly two-thirds support the increased use of technology in education. But that faculty and administrators typically stand at opposite sides of the debate highlights the institutional reality of online learning, and even more so the imperative for administration to understand how students and faculty view the online environment.

While the debate over the rigor of non-traditional learning environments plays out in circles of academia, another angle from which to view the problem arises in recent studies of massive open online courses (MOOCs, introduced in 2012), open educational resources (OERs, a more recent phenomenon), and badging, or micro-credentials (the latest trend). Making sense of this landscape can be difficult. Higher education institutions are increasingly moving in a direction in which course materials become unbundled from the typical course progression toward a degree, and instead are hosted online, realigned within curricula of increasing specialization, and then “stacked” to yield a new suite of credentials. These may count toward a traditional degree or indicate competency in a skill or discipline crucial to a student’s professional development. A recent report from the U.S. Department of Education’s National Center for Education Statistics (Cronen et al., 2017) found that 27 percent of adults reported having a non-degree credential. And fully two-thirds of these non-degree credential holders reported having earned their most important work credential from a college, technical school or
trade school. Furthermore, degree-granting institutions find themselves sampling from the “freemium” model introduced by technology companies, which offer basic features for an app or service, and then charge a fee for premium content. Commentators have described this process as the “commoditization” of content. For higher education institutions, this means offering introductory-level courses in a program of study at a reduced fee or even for free, and then charging fees for credentials, certificates and degrees verifying completion of a course of study (see iMBA, Northeastern partnership with IBM). Ideally, the student returns to the institution over the course of his or her career for additional credentials and degrees, as skills need updating and careers shift in a constantly changing labor marketplace.

From the faculty perspective, the question of developing or employing open educational resources is salient, as they seek out innovative means of teaching their subjects, or adopting open source materials developed by other experts in the field for the same purpose. Recent studies of MOOCs show high levels of educator participation within courses. In a survey of 11 MITx courses, one in four participants identified as a teacher—either currently active or in the past. And teacher participants contributed to discussion boards at a much greater volume, demonstrating the curiosity and demand for discovering new methods for teaching and learning (Seaton, et al., 2015). A more recent study of four years of MOOC participation in MITx and Harvardx found that 32% of survey respondents reported being or having been a teacher, with 19% these respondents reporting teaching the topic of the MOOC (Chuang and Ho, 2016). In order to meet this demand, higher education institutions must focus resources on promoting faculty development of MOOCs and open educational resources, and design platforms and credentials that meet interoperability and accreditation standards that allow for licensing agreements for use outside of the home institution. This study focuses on one such initiative, a
set of online curriculum materials intended for use in data analytics coursework wherever instructors are willing to implement it.

**Significance of the Research Question**

The rationale for this study is the researcher’s interest in expanding research on technology adoption patterns among instructors in higher education, with the purpose of clarifying design issues in developing and promoting the adoption of open source educational materials. The focus of this study is the motivations and innovation-decision processes of faculty members who adopt an open source educational resource to teach data analytics. Insights drawn from the study should inform the efforts of administrators and faculty members seeking to expand open educational resources and to promote innovation in teaching and learning. The aim of the initiative under study is to spur adoption of an open-source educational resource in classrooms outside of the institution in which the resources were developed, but the findings will have implications for the design of future resources, the supports faculty will require for successful adoption, and insights into the traits of innovators and early adopters.

This study is embedded in a higher education environment in which online learning is expanding, but also in which institutions are experimenting with new configurations of instructor roles, content delivery platforms and student recruitment strategies. In other words, institutions are still sorting through the role that technology will play in teaching and learning and how to promote its adoption once investments are made. In their annual survey of higher education institutions, Allen and Seaman (2015) found modest growth in the number of students taking at least one distance course between 2013 and 2014, growing at a clip of 3.9%. The previous year’s enrollments had grown 3.7%. Currently, 28% of enrolled students take at least one online course. Particularly noteworthy, when MOOCs first became mainstream around 2012, much of the
popular commentary on online learning spoke of vast waves of disruption flooding into the business of educating college students. The Harvard theorist on disruptive innovation, Christensen (2011), argued that for-profit universities, which offered much of their courses online, were outcompeting traditional brick-and-mortar institutions, which would have to disrupt themselves or fail. He forecasted that by 2014, 50% of college students would be enrolled in at least one online course. In fact, the number is half of that. And for-profit institutions have seen not only a decline in enrollment, but a decline in online enrollments. Meanwhile, online enrollments have increased at traditional public and private institutions.

Another trend that has reversed is the number of chief academic leaders that say online learning is critical to their long-term strategy, representing 63% of institutions in 2015, falling from 70.8% the previous year. However, administrators at institutions that already offer online learning still view it as part of their long-term strategy at about the same rate as before, or around 77%. And blended learning is viewed with increasing favorability by both faculty and administration. So just as the push toward online learning yielded a new appreciation for blended and flipped learning environments, so too has the MOOC revolution yielded a greater interest in open source teaching materials and unbundled credentials. The first wave of innovation yielded a second, in which the media and delivery strategies for teaching and learning were refined.

The most telling trend is that online enrollments are growing while overall higher education enrollments are falling, which begs the question as to what rationales institutions adopt to expand online learning and further investments in technology. And there are many. When Allen and Seaman (2007) conducted their fifth annual survey in 2007, they found that most institutions cited extending course offerings to non-traditional learners and growth in continuing
and professional education programs as their motivation. To clarify, broader reach, rather than revenue streams, were the goal.

Picciano (2015) noted that 2012 marked the first year that public institutions, in aggregate, depended more on tuition than state allocations for their funding. He cautioned that higher education institutions should tread lightly if they set out to offer online education under the assumption that it would serve as a revenue generator. But expanding access and reaching a broader population of students is a warranted goal. And professional education and graduate programs have been a natural fit for online learning, as they provide the flexibility required by working students (Bacow et al., 2012).

In addition to responding to the pressures of competition within higher education, institutions have sought to respond to demands of the labor marketplaces. Micro-credentials have been touted to fill a space where traditional degrees have failed to fit students’ and employers’ needs. In the case of data analytics education, the demand for graduates with skills in data analysis has grown only more pronounced. Phelps and Szabat (2017) cited research from McKinsey, which predicted that by 2018 the US will face a shortage of 1.5 million managers, analysts and other workers proficient in analytics. They also cited a report from Price Waterhouse Coopers arguing for increased analytics instruction in undergraduate accounting curriculum. This phenomenon has even broader implications in modern economies where the length of skill currency appears to be shortening, which has brought the notion of lifelong learning to the fore. Evans, Schoon and Weale (2013) found evidence that participants in lifelong learning experienced improvements in their employability and employment prospects. So even if higher education institutions manage to educate students in the data analytics skills required in
the immediate future, it remains likely that those same students will require further skills upgrades in the not-so-distant future.

Lastly, the pressures faced by today’s students also apply to the faculty who would teach them. Current incentive structures for full-time faculty place an emphasis on research, but a new class of teaching professionals should also be cultivated to explore new frontiers in teaching, both with new pedagogical methods and in emerging fields. In doing so, these teaching professionals, with an eye toward innovation and early adoption, can marry their own career ambitions to those of their students. The success of OERs and other technology-enabled curricula hinge on the drive and creativity of this type of digitally-savvy educator.

Research Problem

Universities make regular investments in digital teaching tools, micro-credentials and open source educational resources, but they are just beginning to gather information about the impact of these investments, the motivations of instructors who would adopt these materials, and the role instructors play in supporting diffusion. Gaining a deeper understanding of the adoption patterns of instructors can inform administrators’ efforts to spur innovation in teaching and learning. This could potentially yield greater value from technology investments, harness faculty creativity in teaching, and broaden access to students.

This study focuses on the motivations of faculty members attempting to adopt an open source data analytics curriculum, and the effect this decision to adopt has on their peers. The purpose is to investigate the salient characteristics of early adopters, their decision making process, and the role they play in spurring innovation at their home institution.
Research Question

What motivates instructors to adopt an open-source digital teaching tool?

Definition of Key Terminology

**Term 1**-MOOCs – Massive Open Online Courses, typically offered for free in a cohort model, with the opportunity to purchase a certificate or credential upon completion of the course.

**Term 2**-OER – Open Educational Resources, a portable form of instructional content developed for free use for instructors and students, hosted and delivered online.

**Term 3**-IDT-Diffusion of Innovations Theory, or the social process through which technology adoption occurs over a period of time, during which technology use becomes diffuse across a population via its communication channels.

**Term 4**-LMS-Learning Management System, an online portal where course materials, assessments and enrollments are hosted and instructors and students interact. Examples include Blackboard, Moodle and Canvas.

**Term 5**-Synchronous learning-when learning occurs in the same scheduled time period, whether face-to-face or online.

**Term 6**-Asynchronous learning-when learning occurs at the individual level but according to a student’s individual schedule.

**Term 7**-BL-Blended Learning – a course that meets both online and face-to-face.

**Term 8**-Hybrid Course – a course that alternates time increments between meeting face-to-face and online. A blended course with a consistent, alternating structure for when and how instructors and students meet.
**Term 9**- Flipped Classroom – a classroom structure in which didactic materials are typically delivered asynchronously and online, while face-to-face meetings involve problem-solving and active learning.

**Diffusion of Innovations Theory Terms**

**Term 1**- Homophily – people who share much in common in terms of education, believes, socioeconomic background, etc.

**Term 2**- Heterophily - people who do not share much in common in terms of education, believes, socioeconomic background, etc.

**Term 3**- Localite Communication Channels – informal, peer-to-peer.

**Term 4**- Cosmopolite Communication Channels – consumed via mass media or other expert resources.

**Term 5**- Relative Advantage - the perception that an innovation is superior to the practice or idea it replaces.

**Term 6**- Compatibility - the extent to which an innovation is consistent with existing values, past experiences, needs, etc.

**Term 7**- Complexity - the degree of difficulty to understand and use an innovation.

**Term 8**- Trialability – the extent to which an innovation may be tested before adopting.

**Term 9**- Observability – the extent to which the results of adoption are apparent to others.
Theoretical Framework

This research is novel in that it investigates an innovation in teaching that is newly emerging, but it also has much broader implications in that it deals with the psychological negotiation that occurs when an individual attempts to evaluate and adopt an innovation. Professional context, pedagogical preference and social networks collide to compel individuals to contemplate change and enact it. As for the professional context, it is clear that universities continue to allocate funding and personnel to provide infrastructure and support for education technology, and academic IT departments are tasked with the maintenance and adoption of learning management systems, third-party tools and training initiatives. But as these initiatives grow, much remains to be explored about the ways in which faculty adopt technology tools. Within a voluntary system, how do they make decisions around which tools to adopt and how? What influences these decisions? And what are the key measures of success when the goal is to encourage widespread adoption of a particular technology? To answer these questions, Rogers’ (2003) diffusion of innovation theory provides a mature and salient framework for tracking and forecasting this type of social change, as it models the factors that motivate adoption, the categories of potential adopters, and the stages of adoption across time—from isolated to diffuse practice.

Diffusion of innovations theory has been applied to a number of socially-oriented inquiries outside of higher education, including agriculture, economic development, medicine and government. Its origins stem from a small group of rural sociologists at land-grant universities who were concerned with the adoption of innovations in farming practices. With the widespread adoption of the Internet in the 1990s and the role of information technology expanding into teaching and learning, diffusion of innovations theory has enjoyed a modest
Theoretical Foundation

Rogers (2003) argued in his seminal text, *Diffusion of Innovations*, first published in 1962, that the early seeds of diffusion theory initially took hold around a century ago in Europe, as the fields of sociology and anthropology were emerging. Gabriel Tarde, a French jurist of the early 20th century, tracked social trends he observed in courtrooms, and eventually wrote about these phenomena in early sociological treatises. He noticed patterns of invention and imitation, and was principally interested with learning why certain innovations took hold in human behavior while others did not (Rogers, 2003). A contemporary of Tarde, the German Georg Simmel was trained in philosophy but was one of the earliest lecturers in sociology at the university in Berlin. He was concerned with the concept of the stranger, or an individual who is only loosely associated with the social system he inhabits. He argued that the position of the stranger enabled him to view social systems differently and in turn pursue innovations that others, more fully embedded in the system, would be prone to overlook. Simmel’s work paved the way for sociological concepts such as social distance, heterophily and cosmopoliteness,
which are trademarks of modern diffusion theory. British and German-Austrian schools of
diffusion theory emerged shortly after Tarde and Simmel’s work. These theorists offered
diffusionism as an anthropological lens that could explain social change as a product of
innovations spread from a single source (Rogers, 2003). Modern diffusion theory is less
cconcerned with locating a single source of innovations, and more concerned with the processes
in which they spread.

Diffusion of innovations theory, as it is applied today, can be traced back to a
foundational study by Bryce Ryan and Neal Gross (1943). Researchers at Iowa State University,
they interviewed farmers to track the adoption of hybrid seed corn, which produced higher yields
per acre and was more drought-resistant than open-pollinated corn. According to Rogers (2003),
this study established the research methodology that would be used by the majority of diffusion
researchers who followed: ”retrospective survey interviews in which adopters of an innovation
are asked when they adopted, where or from whom they obtained information about the
innovation, and the consequences of adoption” (p. 33). As a result, a cottage discipline of rural
sociologists studying diffusion sprouted, and eventually diffusion theory spread to other
disciplines. Rogers (2003) summarized the paradigm established by the Ryan and Gross study:

The heart of the diffusion process consists of interpersonal network exchanges and social
modeling by those individuals who have already adopted an innovation to those
individuals who are influenced to follow their lead. Diffusion is fundamentally a social
process (p. 35).

What all diffusion theories have in common, according to Rogers (2003), is that adoption
consistently occurs on an S-curve, in which an innovation is first adopted in isolation by
innovators and early adopters, then en masse by an early and late majority, and finally, if at all, by a few remaining “laggards” (Appendices A and B).

More recent research on education technology in higher education has applied diffusion of innovations theory to problems of technology adoption. The shift toward an institutional perspective, as recommended by Redmond (2003), has been noticeable. Graham, Woodfield and Harrison (2013) explored institutions in different stages of adoption of blended learning to uncover issues related to institutional policy. Based on this study, Porter and Graham (2016) applied the same model for stages of adoption to explore how institutional strategy and structure and support issues could facilitate or impede adoption of blended learning. Levin, Stephan and Winkler (2012) compared rates of adoption across different types of institutions to determine if some were more inclined toward adoption than others. Meanwhile, interest in the attributes of adopters themselves has not waned. Tabat and Johnsrud (2007) studied the relationship between faculty attitudes toward technology and distance education to track adoption. And Vishwanath (2005) examined the personality attributes of adopters, as well as personal histories of information search and technology ownership, to establish links to rates of adoption.

**Criticism of Diffusion of Innovations**

In the early stages of diffusion of innovations theory, relatively few critical assessments were leveled against the theory, according to Rogers (2003). It was not until the 1970s that scholarly critique of the theory began to address some of its limitations. Rogers (2003) noted some of the more pronounced criticisms of the theory, and suggested that the criticism could provide a benefit to future diffusion research.
The first charge against diffusion of innovations research is that it implicitly has a pro-innovation bias, which is to say that it is based on the assumption that the innovation under study ought to be adopted and diffused as quickly as possible, without rejection or re-invention. Rogers (2003) argued that pro-innovation bias can occur for a number of reasons. First, diffusion research is often funded by organizations with an interest in the adoption of an innovation. Second, innovations are frequently studied after adoption, which paints the innovations as “successful” or inevitable. Third, diffusion studies can sometimes be “overly rationalistic,” presuming that potential adopters evaluate innovations purely on their own merits. Other criticisms include the charge that diffusion of innovations research is prone to blaming the individual when an innovation is rejected. Similarly, there are issues of recall when adopters or rejecters recount their rationale after the fact. And finally, there are issues of equity in diffusion research. Rogers (2003) noted that a common consequence of the adoption of an innovation is that it can lead to widening a socioeconomic gap between adopters and those left behind. Diffusion research that ignores the socioeconomic consequences of adoption are confined to a merely technical assessment of adoption.

Redmond (2003) echoed similar criticisms of diffusion theory when he argued that it can be overly rationalistic. He maintained that bounded rationality is the underlying hypothesis of diffusion of innovations theory. He also argued that diffusion theory focused too heavily on the individual. To move beyond the individual, he proposed an institutional perspective to account for decisions to adopt or reject an innovation. “The possibility of an informed resistance to innovation, based on values, does in fact happen and is compatible with the institutional perspective,” wrote Redmond (2003). To adopt an institutional perspective of diffusion, Redmond argued that researchers should consolidate the adopter categories to only two sub-
units: innovative adopters and non-adopters. Rather than emphasizing the earliest adopters, the institutional perspective should focus on the role that followers play and the power they wield over the adoption process.

**Rationale and Theoretical Support for IDT**

Diffusion of innovations theory inhabits a fairly crowded space of technology adoption theoretical frameworks. The frameworks frequently share a number of constructs considered to contribute to technology adoption, but researchers typically select frameworks based on perceived fit for each problem under question. Venkatesh et al. (2003) attempted to test the constructs across eight different technology adoption models in order to identify the most salient factors among them, seeking to establish a Unified Theory of Acceptance and Use of Technology (UTAUT). Diffusion of innovations theory was among the eight models.

Based off longitudinal field studies of four organizations where individuals were introduced to new technology in the workplace, Venkatesh et al. (2003) found that at least one construct from each model held across time. They also found constructs that were significant in the initial stages of technology adoption, but not throughout. Ultimately, they theorized that four constructs played a significant role as direct determinants of user acceptance and usage behavior, including performance expectancy, effort expectancy, social influence, and facilitating conditions. They also theorized that equally common constructs, such as attitude toward using technology, self-efficacy and anxiety, were not direct determinants of a person’s intention to use technology. These findings generally give support to the main tenets of diffusion of innovation theory. Ventakesh et al. (2003) identified performance expectancy as a theoretical equivalent of relative advantage (IDT), or the notion that an innovation is superior to the process or technology it is intended to replace. They also found equivalency in both effort expectancy and ease of use
For each of these constructs, Venkatesh et al. (2003) theorized that they would be subjected to moderating influences such as gender, age, voluntary/mandatory context and experience. For instance, they argued that performance expectancy (relative advantage, IDT) would be more salient for younger workers, particularly men, whereas effort expectancy (ease of use, IDT) would be more salient for older women. (The authors cautioned that the differences in gender were likely to be a result of norms more so than biology.) Similarly, social influence was more significant for individuals with less experience and in the earlier stages of adoption, presumably because adoption hinged on gaining favor with management figures in the workplace. And facilitating conditions were found to be more significant among older workers, who may need more support in adoption. One final mediating factor is whether the context of adoption is voluntary or mandatory. Social influence held greater sway in mandatory contexts, and minimal influence in voluntary contexts. Lastly, the authors offered an important distinction for future researchers to keep in mind, which is the extent to which technology adoption perceived as successful at the individual level is also considered successful at the organization level. The notion of diffusion, or the extent to which an innovation spreads within and across organizations, is essential to IDT. So while social influence may not play an outsize role in UTAUT, the communication channels individuals use to evaluate and decide on adoption are important in IDT. Again, Rogers described diffusion theory as primarily concerned with a social process.

Two constructs that Venkatesh et al. (2003) sought to dispense with were attitude and self-efficacy. Attitudes about technology in general, it could be theorized, are not applicable to cases focused on the adoption of a specific tool. Indeed, many workers with negative attitudes around technology are likely to adopt a new technology at some point or another, even in
voluntary contexts. As for the construct of self-efficacy, some research supports the notion that it influences technology adoption in teaching among higher education faculty (Buchanan, Sainter and Saunders, 2013; Ajjan and Hartshorne, 2008, investigating faculty decisions to adopt Web 2.0 technologies). But the problem of causality in self-efficacy invites a circular logic. Professors who adopt more technology in their teaching are likely to have higher self-efficacy. Likewise, professors with higher self-efficacy are more likely to adopt technology in their teaching. That said, there are theoretical merits to the argument that developing self-efficacy among faculty could spur technology adoption, if other factors are also taken into consideration.

Analogous to the adopter categories of IDT, more recent theorists have sought to identify the different stages of technology adoption at the institutional level, as well as the supports required to spur adoption at each stage. Focusing on blended learning in higher education, Porter and Graham (2016) employed IDT and an institutional framework for adopting blended learning (Graham, Woodfield and Buckley Harrison, 2013) to identify structural supports for both adopter categories and institutions in different stages of adoption. Porter and Graham (2016) found that the availability of sufficient infrastructure, technological support, pedagogical support, evaluation data and an institution’s purpose for adopting BL could significantly influence faculty adoption. These were based on the framework of Graham, Woodfield and Buckley Harrison, who argued for different strategies, structures and supports for three different institutional stages of adoption of BL: awareness/exploration; adoption/early implementation; and mature implementation/growth.

Application of the Theory

Because this interpretive phenomenological study investigates early adopters at an early stage of institutional adoption, both IDT and the blended learning institutional framework have
relevant applications. The innovation in question, a data analytics curriculum, had been available for just over a year at the time of data collection, so it can be assumed that the institutions under study are either in the awareness/exploration or adoption/early implementation stage. Likewise, the individuals are among the innovator and early adopter categories. Within the IDT framework, this study will focus on the innovation-decision process, or rather, how faculty members gathered information and evaluated the innovation to reach a decision to adopt, and then follow them through the implementation/confirmation process. Because the participants are all of the early adopter category, the study is also concerned with the communication channels they employ, which could potentially lead to diffusion within their organizations. Collecting early adopters’ thoughts on how their practices and recommendations influence peer behavior will yield information on how an innovation potentially succeeds or fails in transitioning from early adoption to diffuse practice. Employing IDT constructs to craft interview questions will provide an organized framework to assist researchers and university administrators in understanding the early stages of adoption, in order to better facilitate it and, in turn, support communication channels that promote diffusion. That IDT constructs continue to enjoy currency in other technology adoption frameworks demonstrate their usefulness for this study.

Summary and Future Considerations

Diffusion of innovations theory provides a compelling framework for research in the adoption of education technology in higher education. More current research in this field has taken a turn toward an institutional perspective, which presumably helps to steer the research away from some of the pitfalls of earlier diffusion theory. For instance, the pro-innovation and individual-blame biases, which took the adoption of an innovation as a given or blamed individuals when they did not adopt, both failed to adequately address the institutional context of
adoption. (The term “laggard” seems almost pejorative to describe non-adopters. “Holdouts” might be a better fit to avoid blaming the individual.) Similarly, diffusion of innovation researchers have turned toward the institutional perspective largely because technology adoption has become an institutional prerogative, especially given the need to reach a wider array of students and encourage the effective use of institutional investments in technology. While this research investigates the innovation-decision and implementation process of early adopters, it also seeks to understand the perceptions of educators seeking to change their teaching practices and the communication channels available to them to influence their peers.
Chapter 2: Literature Review

The current trajectory of higher education reveals an unbundling of programs and courses to produce new configurations of certificates and credentials, with the goal of increasing access and producing outcomes better aligned with a rapidly changing workplace. As this change has unfolded, instruction has been delivered in increasingly online and blended formats. And institutions have begun to reorganize themselves to align institutional goals with societal pressures and market demands. Wrapped up in this change, the faculty role—while altered—remains central.

This study focuses on the decision-making process of faculty adopting an open source data analytics curriculum. It seeks to examine the factors that motivate adoption of open source technology and curriculum, and promote diffusion of professional practice within higher education institutions. Findings from the research will inform administrators and faculty interested in developing and adopting digital course materials, which is essential to reimagining learning pathways that reach a greater volume of learners, yield better outcomes, and reassert the value proposition of higher education.

This study surveys the literature on faculty adoption of digital teaching tools from a number of angles. The first of these establishes the context, or rather the diversified sources of instructional content emerging via MOOCs, OERs and e-credentials in online and blended learning environments. Understanding how administrators and faculty perceive and negotiate these changes is crucial. It bears repeating that the current progression from MOOCs to OER to e-credentials hinges on the role faculty will play in creating new learning environments. Equally noteworthy, student and faculty attitudes on technology and online learning reveal a disconnect in what both expect from the experience. These expectations play into the final theme, which
covers literature on the barriers to faculty adoption of technology, and the professional
development initiatives deployed to confront them.

The Context

In order to adequately arrive at questions about faculty adoption of technology and OER,
an accounting of the current thrust of higher education is necessary. Perhaps the most obvious
trend is the continuous disaggregation of content and learning pathways. This is arguably more
pronounced at the level of graduate education. A recent report from Poets & Quants (Byrne,
2017) cited the University of Iowa, Wake Forest University, Virginia Tech, Simmons College
and, potentially, the University of Wisconsin, as institutions where leadership had closed full-
time residential MBA programs. These institutions are not exiting the market of business
education, but instead focusing on more specialized programs, with shorter time spans to
degrees, in more flexible online and blended settings. At the undergraduate level, the four-year
residential experience is not likely to disappear anytime soon, but a decided push toward more
personalized, adaptive, competency-based, and stackable degree pathways continues to
accelerate. The gist of both trends is that technology will play a greater role in delivering and
monitoring learning, and a greater variety of degree and credential pathways are emerging.

Adoption of Online Learning and MOOCs

But how did we get here? The emergence of online learning and MOOCs reveal two very
similar stories. Online learning, which has been around for the better part of two decades, was to
represent the first wave of disruption. Growth in for-profit colleges took online learning to a
massive scale, which eventually collapsed in a heap of student debt and degrees of questionable
value. After the bubble burst, online learning did not go away, but instead developed alongside
and within traditional brick-and-mortar programs, offering greater flexibility to students.
Accreditation standards and the labor marketplace kept the disruption of traditional universities in check. This same problem of academic rigor, accreditation and the value of alternative degrees and credentials confronts MOOCs, OERs and e-credentials. The question is of how to verify the quality of a non-degree credential. Hickey (2017) argued in the Chronicle of Higher Education that the solution to verification is not far off, and that higher education finds itself in a similar situation as retail companies in 1997, when e-commerce first arrived. As examples, he cited the Open Badge 1.0 and 2.0 Specifications launched by the Mozilla Foundation in 2013 and 2016, respectively, their adoption by the IMS Global Learning Consortium in 2017, and the Bologna Open Recognition Declaration. All seek to provide digital standards for sharing and verifying non-degree credentials. Adding weight to this trend, a recent US Department of Education report (2017), based on responses from 47,744 working adults, found that 27 percent of the respondents had earned a college certificate or a professional certification or license.

**Teacher Interest in OER**

When MOOCs first arrived, commenters argued they would replace universities. But they did not. Third-party providers of educational content like Khan Academy and Lynda.com have enjoyed some success, but there is little evidence that they have eaten into the higher education market. Instead, MOOCs provided a push toward open educational resources and micro- and e-credentials. They also elicited concerns about retention, as MOOCs tended to have low levels of course completion, most commonly because students were shopping for specific materials within the course. But much the same way online learning was subsumed by traditional higher education institutions, so too have MOOCs been incorporated into existing on-ground and online courses. Bebell and Petersen (2015) demonstrated how an MIT MOOC on computer programming could be successfully incorporated into courses at the community college level.
Griffiths et al. (2015) arrived at similar findings of an initiative to repurpose MOOCs in hybrid courses at the University System of Maryland. Their study showed that incorporating MOOCs in traditional undergraduate courses provided flexibility in the use of class time, enhanced critical analysis skills, provided exposure to different teaching and class discussion styles, and spurred faculty enthusiasm for new forms of teaching. To the last purpose—teacher interest in adopting new technologies and curricula—additional studies have found high levels of participation among teachers in MOOCs. In a survey of four years of MOOCs on the edX platform, Chuang and Ho (2016) found that 32% of respondents reported being or having been a teacher. Similarly, Seaton et al. (2015) found in a survey of MITx MOOCs that more than one in four respondents identified as the same. And not just teachers but also education researchers are exploring MOOCs. In a review of research on MOOCs, Gaevic et al. (2014) found that 75% of the submissions reviewed came from researchers in the field of education. An appetite exists for MOOCs and OERs, which have been incorporated to provide fresh perspectives and high-quality course materials in existing teaching environments. But the move toward OER has not come without its own challenges. For those instructors who have sought out MOOCs and OER, issues of customizability, institutional alignment and technical support persist (Murphy, 2013). Instructors also cite increased time commitments in reviewing and preparing MOOCs and OERs for their courses (Griffiths et al., 2015). Enthusiasm for OERs continues to gain, but the mechanics of production and implementation are still in the early stages.

**The Online Versus Face-to-Face Debate**

Perceptions of MOOCs and OER are still emerging, but they can also be viewed through the prism of perceptions of online learning, since both are delivered either entirely, or at least partially mediated by, online platforms. The perception of MOOCs as the playground of highly
educated tinkerers was well-earned, since completion rates are consistently low. But when deployed as OER in more scaffolded instructional settings, the issue mostly dissipates. Even so, perceptions of online learning in general can vary drastically across administrators, faculty and students. As previously noted, the Babson Survey Research Group found that more than 70 percent of chief academic officers at higher education institutions agreed that online education was critical to their institution’s long-term strategy (Allen and Seaman, 2015). Inside Higher Ed’s (2017) annual survey of faculty attitudes revealed that only half of faculty believe online courses can deliver outcomes equal to face-to-face courses, demonstrating a pervasive skepticism online learning and the motivations behind it. This tension, along with a sustained research interest in the possibilities of online learning, has produced a substantial volume of research comparing online and face-to-face learning.

So what do these comparative studies show? A survey of the most recent literature on online and blended learning yields a variety of topics of interest. The clear leader in the most-cited literature goes to topics on instructional design, or rather, research on the strategies and best practices for implementing online and blended learning (Halverson et al., 2014). This makes sense because of its practical implications. Halverson et al. (2014) conducted a thematic analysis of the 50 most-cited articles and 25 most-cited book chapters in the last decade that pertained to blended learning. They sought to determine what researchers were focused on when studying blended learning. Of these book chapters and articles, 41% addressed instructional design. Meanwhile, 32% addressed topics relating to disposition (perceptions, attitudes, preferences) and 29% related to exploration (benefits, challenges, trends, role of BL). Other topics frequently addressed in the literature included learner outcomes, modes of interaction, technology, demographics and professional development. About 18% of the articles were concerned with
comparing blended, online and face-to-face models of education, demonstrating that comparative studies are still a matter of concern.

**DOE Meta-study**

In 2009, the US Department of Education, perhaps unintentionally, created a wave of enthusiasm for online learning when it released a meta-analysis on research in the field. While some mistook its findings for an unequivocal endorsement of online learning as “superior” to face-to-face learning, the report qualified its findings with some tempered language about whether the results were generalizable. But in a Room for Debate forum on *The New York Times*’ website, experts in higher education cited the report as evidence for expanding online education (“College degrees without going to class,” 2010). Then, as it is now, there was incentive among higher education administrators and leaders in education technology to trumpet online learning as a superior *medium* for education. In their meta-analysis, Means et al. (2010) found that students in online courses performed “modestly better, on average,” compared to students learning the same material in a face-to-face setting (p. xiv). However, they quickly qualified this finding:

Interpretations of this result, however, should take into consideration the fact that online and face-to-face conditions generally differed on multiple dimensions, including the amount of time that learners spent on task. The advantages observed for online learning conditions therefore may be the product of aspects of those treatment conditions other than the instructional delivery medium per se (Means et al., 2010, p. xiv).

Means et al. (2010) also found that courses delivered in a blended format yielded greater gains compared to face-to-face courses. But similar to the previous finding, they cautioned that
most of the studies in the meta-analysis did not account for curriculum materials, pedagogy and
time on task, which may have been the key differences rather than the medium itself (Means et
al., 2010). Studies also vary in the degree to which courses are delivered all online, versus hybrid
and blended models. Some less sweeping findings included results suggesting that online
learning that included activities promoting learner reflection and self-monitoring yielded better
outcomes, and that “online learning is much more conducive to the expansion of learning time
than is face-to-face instruction” (Means et al., 2010, p. xviii). Building on this notion, the authors
suggested that because asynchronous learning is inherently self-reflective, there was a possibility
that it could be more conducive to deep learning (Means et al., 2010).

Critiques of the DOE Meta-study

One of the major drawbacks of the DOE study was that it failed to include information
about retention rates in online courses, which can vary drastically from face-to-face courses,
especially in certain postsecondary settings. In a critique of the DOE’s findings, Jaggars and
Bailey (2010) cited a number of studies on postsecondary education showing that while students
who completed online courses fared as well as students in face-to-face iterations of the same
courses, students in online courses were less likely to complete the course. Failing to take
attrition rates into account, in turn, undermined the findings that learning outcomes were better
for students of online courses. Moreover, students from certain demographic backgrounds and
levels of academic preparation had markedly different attrition rates compared to other learners
in online courses. In a study of more than 500,000 courses taken by roughly 40,000 students in
Washington State’s community and technical college system, Xu and Jaggars (2014) found that
males, younger students with lower levels of academic preparation and Black students “were
likely to perform particularly poorly in online courses relative to their performance in face-to-face courses” (p. 648).

Other criticisms from Jaggars and Bailey (2010) noted that the DOE meta-analysis lumped fully online and blended courses into the category of “online courses.” 20 of the 23 courses in the study identified as hybrid required students to spend the same amount of time in the physical classroom as their peers in face-to-face settings, which meant that the online portion likely represented additional work and more time on task (Jaggars & Bailey, 2010). And of the 28 studies on fully online courses in the DOE report, more than half were not semester-length, but rather short, topic-specific interventions (Jaggars & Bailey, 2010). When filtering for studies conducted on graduate and undergraduate students in semester-long online courses, the total narrowed down to seven.

Examining these seven studies of fully-online, semester-long postsecondary courses, Jaggars and Bailey (2010) found five of them yielded no significant difference in performance between online and face-to-face courses. One study yielded better outcomes for online learners; another yielded better outcomes for face-to-face learners. And all seven of the studies were of courses at mid-sized or large universities, five of which were rated as “selective” or “highly selective” by U.S. News and World Report, suggesting that most of the students were academically well-prepared (Jaggars and Bailey, 2010, pg. 8). For students who are less academically prepared, including attrition rates tells a much different story. Jaggars and Bailey (2010) noted that studies of community colleges generally yield withdrawal rates in the range of 20-30%, with higher rates for online courses.
Both Jaggars and Bailey (2010) and Xu and Jaggars (2014) admit that in postsecondary settings with well-prepared students, learning outcomes in online courses are typically just as good, and sometimes better, than in face-to-face courses. But in community colleges and technical schools, with less-prepared students, they call for a pre-screening process, early warning mechanisms and scaffolded instruction to support students as they navigate the online learning environment (Xu & Jaggars, 2014). Without these supports, they warn, expanding online learning on the basis of expanding access may in fact yield the opposite result, given the achievement gaps that exist in online learning for certain populations.

**Post-DOE Studies**

In a meta-study targeting research published after the DOE study, Lack (2013) found similar results, in that neither medium significantly outperformed the other. Lack also noted the difficulty of conducting comparative studies like these, wherein randomization is hard to obtain (students self-select into courses), performance measures often vary across programs, and results are sometimes self-reported. Arbaugh et al. (2009) argued that “merely comparing performance scores in an online and a classroom-based course will not yield many new insights” (pg. 83). Similarly, there can be a tendency in such studies to report what seems exciting and successful but may not warrant generalization.

**Conclusion**

While the literature comparing learning outcomes in online versus face-to-face courses still has room to mature, the vast majority of it yields no conclusions as to whether one is superior to the other as a medium. And it begs the question of whether it is entirely necessary to obtain this judgment, or even possible. Both have proven to yield successful learning outcomes. And in some cases, they do not share the same instructional components that even warrant
comparison. However, in certain segments of the student population, online learning poses identifiable obstacles to success. Learners who have not developed certain habits of mind in terms of self-regulation, or are academically under-prepared, perform noticeably worse in online learning, so there is reason to express caution in expanding online learning in their direction. It may not achieve the objective of expanding access. In this scenario, faculty concerns are warranted. Face-to-face learning provides certain advantages in terms of structuring and monitoring the learning process, which less-prepared learners require. Another point to consider is that most of the literature comparing online to face-to-face learning comes from postsecondary and professional training environments.

From the perspective of faculty adoption, being able to articulate the proper application of technology to learning will prove useful in gaining support for any initiative that adopts digital teaching tools. Otherwise, faculty may persist in the belief that technology detracts from the learning experience, and thus be less inclined to adopt it. This perception presents a significant obstacle when new digital teaching initiatives are launched, as the literature demonstrates that the importance of the faculty role only increases in online environments.

**Student and Faculty Attitudes on Online Learning**

Studies on student and faculty attitudes toward online are important for administrators to consider, because these attitudes promote or hinder the success of an initiative to adopt technology or develop online instruction. A few researchers have noted the difficulty of the administrator’s task. Arbaugh et al. (2009) argued that “those with administrative responsibilities have little evidence to guide them when making decisions regarding the comprehensive design, emphasis and conduct” of faculty and students in an online setting (p. 71). The same problem applies to the growing staff departments within universities devoted to instructional design and
technical support, which frequently rely on experience and anecdote to pursue change and design policy. Halverson et al. (2014) bemoaned the fact that instructional design and technical support staff are rarely expected to perform research on the field. That said, these support positions are slowly professionalizing in the direction of producing scholarship.

**Themes of Faculty Attitudes on Teaching with Technology**

Unfortunately, the literature on faculty attitudes toward online learning is not as robust as it is on student attitudes (Arbaugh, 2009). When faculty attitudes are explored, usually it is for the sake of comparison with student views. Tanner, Noser and Totaro (2009) conducted surveys of 890 undergraduate students at two southern universities in the US and of 200 business faculty throughout the US to compare their perceptions of online learning. There were some key points in which their attitudes differed. Most markedly, they differed on questions pertaining to the importance of face-to-face interactions. Faculty considered it significantly more important than did students. Faculty also demonstrated a significantly higher level of agreement with the statement that they would miss this type of interaction (Tanner, Noser and Totaro, 2009). Similarly, Roby et al. (2013) found that the single most important factor cited by students for taking an online course was knowing ahead of time how much face-to-face time would be required (p. 31). Tanner et al. (2009) speculated that because students were more likely to conduct many other parts of their lives in online environments, they were less likely to find face-to-face interaction quite as necessary. However, Roby et al. (2013) found that students and instructors considered instructor-student interaction important. But they disagreed on the importance of peer interaction and building a sense of community. Faculty felt these components were important while students found them to be less so (Roby et al., 2013). Marzilli (2014)
found that faculty believed the humanistic value of teaching and learning was lost through the online medium.

When asked if they would take or teach as many online classes as possible in the future, faculty strongly disagreed that they would while students only slightly disagreed (Tanner, Noser and Totaro, 2009). Perhaps most telling, faculty and students disagreed on whether the technology used in the course increased the value of the experience. Faculty believed it did not, whereas students believed it did (Tanner, Noser and Totaro, 2009). Roby et al. (2013) also found that students ranked the “interesting presentation of material” highly, suggesting that technology-mediated delivery mattered to them (p. 31). Arbaugh and Benbunan-Fich (2007) echoed this when they found that “higher levels of learner-system interaction are positively and significantly associated with medium satisfaction” (p. 862). This supports the idea that the quality and the structure of online delivery does have a positive impact on student attitudes. Bailey, Hendricks and Applewhite (2015), in a study on student perceptions of online assessments, found that students preferred assessments that had an innovative feature compared to traditional assessments. These student attitudes suggest that there could be a “Hawthorne effect” at play, in that students, when encountering a novel or seemingly innovative instructional strategy, may be more inclined to engage with it.

**Changing Roles**

Another angle in the research on faculty attitudes considers the newly-formed roles that online learning requires of its participants. A common goal of instructional design initiatives is to make the learning process more student-centered. The notion of student-centered or self-directed learning places more of the responsibility on the student in the process of knowledge creation. Meanwhile, the instructor, who had previously been the primary conveyer of knowledge, adopts
a role more reminiscent of a curator, facilitator, strategist and coordinator of learning, according to Bailey et al. (2015). This necessitates that both student and faculty must overcome assumptions attached to their previous roles, which can prove challenging. Some of these assumptions include “students do not learn without a teacher present,” and “my students cannot possibly understand this textual content without my lectures” (Bailey et al., 2015, p. 115). Roby et al. (2013) found that instructors were most discouraged by the time they believed they would have to devote to monitoring, facilitating and tracking online courses. Students also expressed reservations about being allowed too much autonomy, or being expected to demonstrate more self-discipline (Roby et al., 2013). Kim et al. (2014) found that, in a flipped classroom environment, students struggled to regulate themselves when working in groups on problem-solving activities. They were unaccustomed to managing the task of organizing the work and collaborating without the instructor’s guidance, which faculty must keep in mind as they adopt and design course materials for online learning.

**Conclusion**

In contemplating the development of online or blended learning programs, university administrators would be well-advised to consider student and faculty attitudes. Similarly, while this study focuses on faculty early adopters of OER, the shared concerns of faculty in general must also be taken into account, including potential late adopters. Administrators would also be wise to address the components of online learning that faculty believe subtracts from the teaching and learning experience, including meaningful student-instructor interactions and a sense of community. Budgeting time, support staff resources and incentives for online course development, as well as articulating policies for professional development and reorganized teaching responsibilities, will also be important.
To further capture student interest when introducing new modes of learning, faculty will have to address some of the anxieties that students have with learner role changes. These include lacking confidence in the self-directed nature of flipped and online coursework, the perception that workloads in online environments are sometimes greater, and perhaps finding ways to emphasize that peer interaction is important to the learning process, no matter the medium.

**External Barriers to Adoption**

Research on the barriers to faculty adoption of technology frequently turns to theories of change in organizational development. Within this field, a useful way to divide barriers is Ertmer’s categories of first- and second-order barriers to technology adoption. These include extrinsic (first-order) and intrinsic (second-order) barriers (Ertmer, 2010). First-order barriers involve notions such as faculty perceptions of administrative or IT support, whereas second-order barriers pertain to self-assessments of technical expertise or teaching philosophy. Here the focus is on how faculty describe these barriers as reasons for adopting or eschewing technology in their teaching, starting with external barriers and moving on to internal barriers. And both categories of barriers suggest an interplay at work, where the removal of one can reveal the existence of another. Ertmer (1999) also argued that second-order barriers are typically considered the more difficult to overcome, as they are less tangible, more personal, and more deeply ingrained. Research on first-order barriers can be organized into five different categories: vision; infrastructure and support; access; perceived effectiveness; and changing roles.

**Vision**

Any initiative for faculty adoption of technology requires administrators to articulate a clear vision for how the program will be adopted, what is expected of faculty in the process, and how the goals of the program will be measured. According to Ertmer (1999), faculty must also
have opportunities to view examples of the kind of work they are expected to produce, convene with peers in evaluating it, and then collaborate in producing new teaching strategies with technology. Reid (2014) noted that implementation projects with no specific goals leave faculty and departments with no way to measure success. And the introduction of new technology frequently comes with unintended consequences, which, without plans for mitigation, leaves projects mired in stalled progress and ambiguity. Projects with limited vision frequently yield to past modes of operation, breakdowns in communication, and resistance. As Kopcha et al. (2016) found, initiatives that hope to spur innovation must be clear about what innovation and effective technology use mean. “The importance of how language is used in professional contexts cannot be overstated,” they argued—“words matter” (Kopcha et al., 2016, pg. 956).

### Infrastructure and Support

Asking faculty to adopt technology also implies an IT infrastructure and support system that faculty can rely on as they work to incorporate technology in their teaching. It could be argued that universities have made great progress in this arena, as learning management systems (examples include Blackboard and Canvas) and in-house technical support are standard issue. But if these systems and supports are deemed to be lacking by faculty, they can be among the more imposing barriers to technology adoption.

The literature is rife with examples of faculty citing lack of support as a determining factor in the decision to not adopt technology in their teaching. These include complaints of unfocused support, untimely or inappropriately-scheduled support, and training that merely bombards faculty with a list of technology tools without a pedagogical context for their use (Reid, 2014).
In a study examining the factors involved in faculty technology use, one of the most commonly-cited factors was structural constraints (Buchanan et al., 2013). Faculty were most likely to agree with statements like “there is limited availability of university resources to allow the use of technology-enhanced learning,” and “there is limited support available (e.g., technical and/or admin.) for new methods” (pg. 8). Likewise, Porter et al. (2016) found that across all categories of technology adopters, from innovators to laggards, nearly half or more of faculty cited infrastructure issues as a problem that would significantly influence their decision to adopt new technology. This leads to the logical conclusion that infrastructure must be in place for faculty to trust that change is worthwhile and, if they falter, will be supported.

**Access and Control**

Extending from the support problem is another one—that of access to appropriate technologies, along with faculty perceptions of the control they wield over these technologies once they become available for use. Concerns about control relate to whether the tools available are customizable, and to whom online course materials belong. It should be noted that most universities consider faculty work produced for specific online teaching projects as works-for-hire, which cedes intellectual property rights to the university, but usually with the understanding that faculty reserve the right to reuse and alter the materials (Hoyt & Oviatt, 2013).

On the matter of access to technology, sometimes there can be too much of a good thing. Rather, simply providing access to technology does not guarantee faculty will use it. Some researchers have found that making technology available yields minimal impact in terms of increasing usage or having an effect on learning (Reid, 2014). Reid (2014) and Bacow (2012) also noted that decisions to purchase technology are typically made without faculty input, which might also effect faculty willingness to adopt, if they perceive an initiative as a top-down
assignment. This problem refers back to that of vision, especially in cases where faculty were not involved in the design of an initiative and its purpose is unclear, resulting in “publicly adopted but not implemented” technologies (Reid, 2014, pg. 392).

Bacow et al. (2012) found that faculty concerns over control, customization and intellectual property recurred as prominent barriers in faculty adoption of technology. Faculty are resistant to the idea of using online teaching materials that were designed by others, whether by peers, publishers, or a combination of the two. Wang et al. (2013) found that across a number of measures of the re-configurability of a learning management system, all had a significant impact in helping faculty to use the LMS effectively. Similarly, the idea of “plug-and-play” learning materials does not sit well with faculty. They generally take a great deal of pride in the materials they assemble and edit for the purpose of teaching, which makes the customizability of technology an important design feature. Studies of MOOCs echo this concern. Room for adaptation is important.

If faculty are tasked with adopting innovations, it is common to provide them with contractual assurances that, even if they do not retain copyright ownership of the materials, they reserve the rights of reuse and advisement on any future revisions to the material (Bacow et al., 2012). Such arrangements are generally considered works-for-hire, and it is typical for universities to retain ownership but also yield certain privileges to faculty authorship. This leads to the conclusion that providing access to technology is not enough; but rather, institutions must also allow for faculty to customize the materials they curate and produce, and to alter them for future use. The movement toward OER points in this direction.
Perceived Effectiveness

Institutional barriers to adoption share many general characteristics, but site-specific barriers frequently arise in the day-to-day interaction between faculty and technology, which can deter faculty from future use, or persuade peers that adoption is not worth the effort. Reid (2014) noted that faculty often cited the reliability and complexity of technology as barriers. If technology did not work the first time it was used, faculty stated that they would be reluctant to use it again. Likewise, because some education technology tools originally were designed for uses outside of education, it is not always clear to faculty how they should be used for teaching. This ambiguity leads to reluctance to adopt, as well as the impression that it will take an inordinate amount of time to learn how to use the tools.

Buchanan et al. (2013) found that perceived usefulness was a significant contributing factor to faculty adoption. Faculty who agreed with statements such as “students won’t react well to these methods,” “technology-enhanced learning methods are not suited to my subject,” and “I feel that using new methods is risky,” were less likely to adopt technology in their teaching (pg. 8). And without means of measuring and demonstrating technology effectiveness, this perception is unlikely to be overcome.

Changing Roles

The last category of first-order barriers straddles both worlds of external and internal barriers to adoption. The changing roles of faculty in technology-enabled teaching represents both an external reality, in which administrators are turning to lower-cost adjunct faculty to teach larger numbers of students, as well as faculty perceptions of the future of their own roles in the university. This problem relates back to that of ownership and control, and the nature of the work of developing online course materials. Reid (2014) rightly argued that the rise of technology in
teaching and learning has also coincided with an unbundling of the faculty role. Projects to create online course materials typically involve multiple professionals from different specialties, including graphic artists, instructional designers, web developers, faculty members and project managers. Whereas previously the faculty member had the sole responsibility of course design, albeit within the bounds of department curriculum, now the faculty member finds herself conceding portions of control to a number of different professionals, with whom she is likely to have had only limited working experience. This can prove disorienting.

Another limitation is the time requirement involved in developing online courses, which can be significantly more burdensome than designing courses for on-ground delivery. If these time commitments come in addition to the standard teaching load, they can be overwhelming. Many studies cite time allowances as a positive incentive for faculty to adopt technology, but administrators are reluctant to provide for these (Reid, 2014). Additionally, institutions must provide for training to equip faculty with technical and pedagogical skills for the online environment.

Interestingly, monetary incentives are ranked by faculty as among the least enticing for adopting technology. Porter and Graham (2016), in a study on barriers to faculty adoption of blended learning, found that stipends and tenure/promotion were among the incentives that faculty cited most frequently as having “no influence” on their decisions. In the same study, time allowances were reported as more enticing, but Porter and Graham suggested that this also may have been a result of the larger-than-average teaching loads of their test subjects.
Conclusion

First-order barriers are typically the primary target of administrators when rolling out new technology, and this is to be expected, as they represent tangible obstacles that are more easily manipulated. Infrastructure and support are essential, without which faculty are likely to view technology adoption as a fruitless task. Merely providing access to tools, infrastructure and support is no panacea. Also required are a vision as to what is expected of faculty, with goals that can be measured for success, and provide clarity and motivation. And faculty must feel that they have control over the tools offered, such that they can tailor their instruction to meet their pedagogical goals. Whether or not they are successful in doing this can affect their perception of whether the tools are reliable and effective. And they must be empowered to provide valuable contributions to the team task of designing instruction aided by technology. Seeking input on technology decisions and designing for customizability instill agency and ownership over the process of adoption.

Internal Barriers to Adoption

Second-order barriers, also known as intrinsic barriers, are typically harder to identify and overcome, because they are personal and more deeply ingrained in the faculty member. Ertmer (1999) noted a common experience among administrators, which is that when first-order barriers are removed—for instance, through an upgrade to more reliable technology infrastructure—second-order barriers can be revealed, as faculty adoption stalls for reasons of faculty predilections or perceptions. Intrinsic barriers can include a number of perceptions, beliefs and attitudes, but here they will be broken down into four categories: sense of loss; educational philosophy; technical expertise; and self-efficacy.
Sense of Loss

Faculty are occasionally ridiculed as obstinate defenders of the lecture, but their perceptions of the relative merits of different teaching strategies should not go unheeded. And the research bears out that faculty believe something of value is lost when instruction occurs without the face-to-face interaction of traditional coursework. Ignoring these concerns risks losing faculty support for any initiative to incorporate technology in teaching.

Tanner et al. (2009) noted that faculty showed a significantly high level of agreement with the statement that they would miss the student-to-student and student-to-instructor interactions that occur in face-to-face courses. Marzilli et al. (2014) found an overall positive stance toward technology in their study of faculty attitudes, but they also found a surprisingly prevalent attitude among faculty that technology contributed to the loss of a humanistic perspective of education. And Bacow et al. (2012) identified several apprehensions faculty have about technology. For many faculty, they viewed online learning as something alien to them, and some held that it undermined the reasons they sought an academic career in the first place. Faculty also fear that pressures to adopt technology are a sideways attempt by administrators to replace faculty jobs. And Kopcha et al. (2016) found a sub-section of faculty who doubted whether deep thinking could even occur outside of the face-to-face classroom. While these fears may not represent majority opinion, it goes without saying that technology adoption initiatives that fail to take these fears into account could ultimately engender resistance in faculty ranks.

Philosophical Stance

One of the more interesting studies on how educational philosophy can affect technology adoption comes from Kopcha et al. (2016), which examined an initiative at a large research university to spur innovation and technology adoption. It surveyed faculty on their views on
what innovation means to them and how technology contributes to it in their teaching. The responses yielded several different categories of viewpoints on the issue.

The group that doubted whether deep thinking could occur outside the context of a face-to-face classroom was already mentioned. This group was generally skeptical of the value of technology. Other groups viewed innovation and technology as playing “a critical part (in) helping students achieve a deeper understanding of their content area” (Kopcha et al., 2016, pg. 954). These educators viewed the development of a deep understanding of content as the purpose of innovation and technology. Another subset defined innovation and technology as a means to “help students gain perspective on their immediate community, focusing less on content and more on social relationships” (Kopcha et al., 2016, pg. 954). Those who viewed innovation and technology in a more positive light would be more receptive to technology initiatives, especially if they can be framed in terms aligned with faculty teaching philosophies on technology.

**Technical Expertise**

The extent to which faculty have familiarity with technology can predict their relative willingness to adopt new technology, as well as the manner in which they might adopt it. The ease with which a new teaching tool can be adopted may entice more faculty to try it, but researchers also harbor concerns that low levels of technical expertise may lead faculty to adopt technology in ways that are not as effective (Reid, 2014). A common hazard is that faculty use technology merely to replicate the way they previously taught. A classic example is the hour-long, voiceover PowerPoint recording. Another concern is that faculty with low levels of technical expertise fear the consequences of adopting technology that does not work the first time around. Learning that is halted by technical issues can sometimes appear on teacher
evaluations, which can lead faculty to surmise that taking risks with technology can damage their reputation.

Lane and Lyle (2010) conducted a study on faculty that asked what effect technological expertise, age and gender had on technology adoption. They found that age and gender had only a limited impact on adoption. Women and men perceived barriers to adoption similarly, but sought support in different ways. Men were significantly more likely to report seeking solutions online, as well as their own trial-and-error, as effective means to overcoming barriers, whereas women preferred seeking support from friends, families, workshops and in-person consultations (Lane & Lyle, 2010). Age also contributed minimally. Despite perceptions that older faculty are less willing to attempt new teaching strategies, they in fact used computers at a similar frequency as younger faculty, but were more selective in the applications they used, employing fewer. The gist was that technological expertise had the most dramatic impact on technology adoption. Moreover, those with greater technological expertise were more likely to make use of self-directed information sources, which was predictive of technology adoption. This resembles cosmopolite social networks in IDT theory, which, according to the authors, suggests that training and support should be targeted to risk-aversives with lower technological expertise, as the innovators are likely to find their way to new technology on their own.

**Self-efficacy**

Along with technological expertise, self-efficacy—or a faculty member’s belief that she is capable of learning and implementing new teaching strategies—can play a role in faculty adoption of technology. Technological expertise can contribute to self-efficacy, but a few modest successes can help build an appetite for technology adoption, even among those who do not
consider themselves the most tech savvy on campus. A sense of competency can sometimes drive risk-taking.

Buchanan et al. (2013) found that internet self-efficacy was positively associated with faculty use of technology. Ajjan and Hartshorne (2008) likewise found that self-efficacy had a significant effect on perceived behavioral control and faculty’s self-reported use of technology. Reid (2014) found that, in some cases, self-efficacy may be more important than technological expertise. While those with low self-efficacy may experience greater difficulties, despite having some tech expertise. And other researchers have noted that faculty who believe their students have stronger skills might also be deterred from adopting technology (Reid, 2014). It is a significant internal barrier. And the direction of causality can be difficult to ascertain, as self-efficacy and technical expertise may be involved in a feedback loop.

**Conclusion**

Internal barriers are in general more difficult to overcome for a number of reasons. Administrators have more control over external barriers, and enjoy greater leverage in their ability to alter them through organizational means. But as has been pointed out, the removal of external barriers can sometimes reveal internal barriers, which are more personal and deeply ingrained.

The sense of loss experienced by faculty cannot be discounted, and administrators should strive to implement technology in a way that either accounts for this or seeks to fill the void. There is no doubt that certain elements of learning derived from the immediacy of human presence are difficult to replicate virtually. Faculty also bring different educational philosophies to their teaching, and technology must be adopted and supported in a way that supports faculty
views on learning. For those seeking deeper understanding or social engagement, tools should be selected and promoted in service of these outcomes. And lastly, varying levels of technical expertise and self-efficacy can have a significant impact on the way faculty engage with technology. Providing consistent and numerous opportunities for faculty to acquire the lived experiences of being successful in using technology—developing skills along the way—should help to remove some of these internal barriers.

**Faculty Development and Support**

Following naturally from the discussion of faculty attitudes on barriers to technology adoption, administrators must ask what steps can be taken to encourage and sustain adoption. Institutions are inevitably at varied stages in their efforts to promote technology adoption in teaching and learning. Those that are in the middle stages have achieved some success in promoting the adoption of technology and the development of online courses and programs, but are still refining their strategy and seeking new ways to push forward. Refining strategy and spurring action compels administrators to focus their attention on three main themes, which include the incentives they can provide to faculty, the supports required to spearhead and sustain their efforts, and the planning and management issues that arise in any effort to lead change. In the search to provide solutions, the literature touches on these three major themes: incentives; supports; and managing.

**Incentives**

Research on the incentives provided for faculty to adopt technology, or to develop and teach online courses, recognizes the practice of linking compensation to these activities. In most instances, stipends are provided to faculty who are involved in institutionally-endorsed efforts to develop online programs, courses or course materials. Hoyt and Oviatt (2013) found that these
stipends could range from as low as $1000 to in excess of $10,000, depending on the scope of the project. Bacow et al. (2012) also suggest providing monetary incentives that reflect the amount of time and level of effort a project entails. Hoyt and Oviatt (2013) found a significant share of universities split revenue generated from online courses with the departments or schools involved in developing and maintaining them, although the universities almost always retained copyright ownership.

Financial incentives are an important ingredient, but much of the research suggests that time allowances may be a greater motivating factor for faculty adoption of technology. However, faculty time and teaching loads are a precious resource that administrators may be even less willing to concede. Bacow et al. (2012) argued for administrators to consider that time allowances may be more effective to motivate faculty than financial incentives. Roby et al. (2013) found that instructors tasked with developing and teaching online courses expressed a clear preference for time allowances over money. They argued that policies on online teaching and learning should recognize the time commitments of faculty, and clearly articulate the expectations for contact hours and normal teaching load.

In addition to time, researchers advocate for evaluation and reward systems that recognize the contributions of faculty when they teach successfully with technology. Bacow et al. (2012) argued that institutions should champion pioneers in the faculty ranks, and other research suggests that early adopters and innovators can have a positive and motivating effect on their peers (Reid, 2014). Most discussions of incentives suggested that faculty use of technology should be a criterion on which faculty are evaluated for tenure review (Roby et al., 2013). Somewhat surprisingly, Hoyt and Oviatt (2014) found that very few institutions considered faculty use of technology in tenure review, which shows an unfortunate misalignment of
university priorities and faculty incentives. This may also be a result of the fact that non-tenure track faculty are more likely to teach online than tenure-track faculty.

**Supports**

Perhaps more than any other issue, researchers tend to agree that providing faculty with robust technical and instructional design support is key. Studies on barriers to faculty adoption of technology return time and again to the problem of providing adequate training and support, both to faculty and students (Roby et al., 2013, Bacow et al., 2012). Keengwe et al. (2009) argued administrators must provide support, encouragement and ample resources to allow faculty to be successful in their jobs. Providing face-to-face instruction for faculty and timely support was equally important, as late adopters tend to lean on these services more than others (Keengwe, 2009, Reid, 2014).

The literature does not side with any particular method of professional development, but researchers tend to agree that it is important. Most faculty believe that it is the institution’s responsibility to provide training (Reid, 2014). And the focus and purpose of professional development efforts can have a real effect on adoption. Courses and workshops that merely bombard faculty with a laundry list of technology tools tend to overwhelm them. And it is equally unproductive to focus on the mechanics of technology tools without a discussion of their pedagogical applications. A well-worn phrase among instructional designers is that technology should not be adopted for “technology’s sake,” but rather to promote more effective teaching and learning. Professional development that does not clarify the relationship of a tool to effective practice commits this sin. And it also risks the dissemination of tools that, though easy to learn and use, may fall into misuse, a result of a misunderstanding of their proper application.
Planning and Management

The broadest category for faculty development centers on how to effectively plan and manage technology adoption initiatives. Incentives and supports are both crucial, but administrators can take additional steps at the organizational level to compel change. These include assessing institutional climate, articulating a clear vision and measurable goals, encouraging creativity, involving faculty in decision-making and addressing their concerns, providing for faculty agency, and collecting valuable data on learning outcomes and program costs.

Understanding the current status of the institution plays a crucial role in obtaining knowledge about what is tenable going forward, and for this reason Keengwe et al. (2009) argued that administrators should conduct an organizational pre-assessment to determine if their institutions have the sufficient equipment, support infrastructure and resources in place. Where they are lacking, administrators must make appropriate investments to provide faculty with the resources required to meet institutional goals. The pre-assessment can also inform the technology vision of the institution, helping to align strategy and investment with mission.

Another problem with initiatives to promote technology adoption or to move teaching to an online environment is that the goals are often too modest. Administrators are tempted by low-hanging fruit, and so they frequently use technology to address course bottlenecks or introductory courses that run a high volume of sections. This addresses real academic problems, but does so in a way that can be bureaucratic and unimaginative. Roby et al. (2013) argued against focusing on bottleneck courses for employing technology, and suggested instead that faculty be given the opportunity to incorporate technology in a way that furthers their research or makes the initiative the subject of a study. Sahin and Thompson (2007) echoed this concern and
supported the notion that tying faculty research (something faculty are passionately interested in) to technology adoption initiatives (which might garner less interest) signals to faculty that the initiative is as much an academic project as an administrative one. It also harnesses faculty talents while supporting the development of new skills, providing tacit acknowledgment of the strengths faculty bring to the process. Additionally, they suggested creating forums that promote collegial interaction, which would help to promote faculty contributions and the cross-fertilization of successful ideas.

An unfortunate part of technology adoption initiatives is that faculty are rarely, if ever, consulted in the procurement process of new technology. This is a rather backward way of planning, because it does not include those who will be directly responsible for technology use. Reid (2014) noted research that argued for involving faculty in this process. And both Reid (2014) and Bacow et al. (2012) argued that administrators should directly confront what technology means for faculty personnel decisions. Some faculty believe that technology is employed by administrators as a means to diminish faculty employment. Addressing this anxiety, and clarifying what technology means for their profession, may not fully dispel these fears, but it can help faculty to trust that they are being dealt with honestly.

Lastly, in order to guide future initiatives, administrators should collect valuable data on learning outcomes and conduct rigorous cost accounting (Lack, 2013, Bacow et al., 2012). Wang et al. (2012) also argued that information on technical and instructional design support should be compiled and analyzed. What support services do faculty most commonly seek out? What happens after faculty obtain services? What are the most common roadblocks, in which faculty are likely to abandon their efforts? The research on technology adoption continues to mature, but there are limited studies on the costs involved in adoption initiatives and online course
development. And there is equally fertile ground for research on how faculty use support services.

**Conclusion**

Research on faculty development and technology adoption naturally focuses on incentives and supports. Both can have a real effect on technology adoption initiatives. The findings suggest that monetary incentives do not motivate faculty as effectively as time allowances. Time allowances can be configured in ways that do not reduce teaching loads, but instead allocate time in the work schedule that is devoted to technology. Policies that clarify this responsibility and reward it via performance evaluations and tenure review have real promise.

Adequate technical and instructional design support are imperative, and the research suggests that it must be timely and sometimes delivered face-to-face. Professional development that focuses too heavily on the mechanics of technology without demonstrating its application to effective teaching practice is likely to fall on deaf ears.

This raises the issue of clarifying what the vision and goals for any technology adoption initiative are. When faculty do not know what is expected of them or how they will be evaluated, motivation will lag. These initiatives must also harness the academic strengths of professors, involve them in the decisions on the types of technologies to adopt, and allow them to exercise control over the tools in their work. Finally, in order to assess current initiatives and guide future ones, administrators need to be diligent in collecting data on faculty use of support services, student learning outcomes, and financial costs. Research in this area has ample room to grow.
Summation

Research in the field of education technology represents the better part of two decades of inquiry into tech-mediated environments for teaching and learning. Early studies were concerned with comparing online and face-to-face learning, while more recent studies have focused on faculty adoption of technology and the emergence of MOOCs, OER and e-credenetials. Findings from the first wave indicate support for the notion of “no significant difference” between online and face-to-face environments, although when retention rates are taken into account, online learning environments are less successful in shepherding less academically prepared students to course completion. In the realm of technology adoption, administrators remain committed to increasing their institutions’ digital footprint. Faculty, meanwhile, remain largely skeptical of their motivations, but an increasing number within faculty ranks continue to upskill in teaching with technology. And MOOC enrollments show educators among the most pervasive participants. An appetite among faculty for teaching resources produced outside the walls of their institutions continues to grow.

This study aims to fill a gap in the emerging research on faculty adoption of OER, or rather, digital teaching tools and curricula developed for broad and adapted use. Gaining a deeper understanding of the motivations and decision-making processes of faculty who seek out these resources will assist administrators in supporting their efforts, and potentially lead to greater diffusion of innovative teaching practices within higher education institutions. In many cases, it could be argued, the preferences and successes of early adopters could inform institutional policies, as they represent the beta launches of next practices in teaching and learning. And the “commoditization” of instructional content lends weight to the idea that not every aspect of curriculum need be developed internally. Instead, the pedagogical creativity of faculty can
harness the work of a broader teaching community, which, when combined with local expertise, can enhance an institution’s points of differentiation. Early adopters that seek out next practices outside of the institution in turn become innovators that reconfigure and enhance teaching practice within the home institution. This study examines the motivations of early adopters of technology in faculty ranks and the diffusion of innovative practice within this dynamic feedback loop.
Chapter 3: Research Design

This study sought to examine an initiative at the researcher’s institution to provide an online, open source data analytics curriculum for courses at the university level. It explored the experiences of instructors, acting as early adopters, to teach data analytics skills and tools to university students. Upon registration on the website, an instructor can gain access to a dynamic, anonymized data set drawn from a large company, as well as tutorials, cases, and assistance in obtaining licenses for data analytics tools such as Tableau and IDEA. The purpose of this interpretive phenomenological study was to understand the decision-making processes of instructors adopting an open source technology tool, and what rationales and motivations drive this decision to adopt. Likewise, it sought to understand what impact this decision to adopt has on the instructors’ peers.

Qualitative Research Approach

Qualitative research is composed of several types of methodologies that collect data in a natural setting to achieve a deeper understanding of the way individuals describe and make sense of human problems deemed significant (Creswell, 2013). The researcher conducts an analysis of data with both an inductive and deductive approach, weaving the voices of the participants and the researcher’s own expertise into a write-up that identifies overriding themes while attending to unexpected findings and particularities. Distinct from quantitative research, which seeks to identify and test a few discreet variables to establish causality and to predict phenomena, qualitative research is concerned with how individuals respond to and make sense of the phenomena in question. Qualitative research does not necessarily run counter to the aims of quantitative approaches, it merely adopts a different set of assumptions regarding the study of human problems—namely, that the same phenomenon can elicit different responses and
interpretations from both participants and researchers. Quantitative and qualitative approaches are sometimes viewed within a strict dichotomy in terms of rigor, which can be misleading when applying the same standards of assessment to projects with different aims (Yardley, 2000).

According to Creswell (2013), qualitative researchers are typically concerned with providing a more holistic account of human experience. The approach is adopted when an issue requires greater exploration, in search of a more complex and detailed understanding. It can empower individuals to share their stories, explain the mechanisms identified by quantitative research, and develop theories and fill gaps where previous research could not provide an adequate fit for the same problem. Because qualitative research depends on the interaction between researcher and participant, and data analysis weighs on the researcher’s interpretation of the data, qualitative research is sometimes considered a more “writerly” research activity (Creswell, 2013; Smith, Flowers & Larkin, 2012). The qualitative researcher must provide a more in-depth accounting of how she arrived at themes and findings, whereas in studies in the positivist tradition, the researcher reports on experimental procedures and compares findings to hypotheses. The qualitative researcher, after a deep dive into personal accounts, must generate a compelling and persuasive narrative for what the data can and cannot tell us.

Ponterotto (2005) argued that qualitative research exists within the constructivist-interpretivist paradigm, in that it eschews the priorities of positivist and post-positivist paradigms. The latter seeks to predict and control phenomena, in search of establishing one universally-apprehendable reality. The constructivist-interpretivist paradigm adopts a relativistic stance, maintaining that there may be multiple, equally valid interpretations for the same phenomenon—that reality and the perception of it are the result of a social and contextual transaction. This
stance does not undermine the findings of quantitative research, but merely casts them in a different light, in terms of what their disclosure means for human beings.

**Methodology**

The qualitative research methodology selected for this study is Interpretive Phenomenological Analysis (IPA). IPA seeks to achieve a deeper understanding of phenomena through the personal accounts of participants making sense of experiences of major importance in their lives. In the case of this study, the participants are instructors who have ventured to adopt an open educational resource to teach data analytics to university students. IPA is uniquely suited to this project because it allows for an interpretive analysis of how faculty make sense of the priorities and purposes of their calling in adopting new methods of teaching. It mines their motivations and interpretations of an issue warranting sufficient attention to compel a change in professional practice.

Scholarly commentary on IPA is widely in agreement that its roots stem from three major philosophical traditions: phenomenology, hermeneutics and idiography (Wagstaff, et al., 2014; Smith et al., 2012; Reiners, 2012; Smith, 2010). Phenomenology was initially developed by Husserl, who saw its work as the deliberate and focused examination of human experience. His was an eidetic, or transcendental, commitment to phenomenology, in that by bracketing the natural attitude toward phenomenon—which meant setting aside our pre-existing categories for understanding—the researcher could enact a reflexive and inward turn, to study how one perceives experience. The goal was to identify the essential qualities of an experience, which could then be applied to future perceptions, overcoming the subjective peculiarities of individual experience. Husserl’s is considered a descriptive form of phenomenology. It holds that conscious
experiences could be described when the inquirer’s bias was bracketed out of the inquiry (Reiners, 2012).

IPA adopts the phenomenological focus of Husserl in attempting to dig deep into the transaction between experience and the individual’s perception of it, but it does so without attempting the eidetic reduction of categorizing certain qualities of experience into essential forms. Instead it grows from the interpretive phenomenology of Heidegger, which is rooted in the tradition of hermeneutics. Dubious of the possibility of bracketing bias, Heidegger instead argued for an interpretive stance that could simultaneously become aware of preconceived notions while attempting to engage with experience (Smith et al., 2012). Personal commitments were not an obstacle to the interpretation, but an existential necessity of the interpretive transaction of meaning making. And IPA takes this one step further in its idiographic focus. Revealing the essential qualities of experience is not the goal so much as pursuing the particular and the unexpected. This is done through the “hermeneutic circle,” in which the researcher attempts to make sense of the participant making sense of her experience. Interpretive phenomenology departs from descriptive phenomenology in that it seeks to “give voice” to a phenomenon, and then to interpret its description in relation to a wider context (Wagstaff et al., 2014). Pulled from Heidegger’s principle of Dasein, it seeks not to describe a phenomenon in its essential nature, but to make sense of it as part of being in the world, constrained by context, personal history and language. This relates to the “thrownness” of existence, or the notion that we find ourselves in certain contexts and attempt to make sense of it, rather than bracketing off our past and arriving at an interpretation of phenomena from some objective nowhere.

IPA is well-suited to this study because, as argued by Smith et al. (2012), it concerns an experience wrapped up in larger issues of life goals and professional projects and relationships,
along with the motivations and obstacles contributing to their realization. IPA trains its focus on matters of existential weight and significance. And the decision to change one’s professional practice counts as this. Arriving at a substantive analysis of how instructors make sense of such an experience is a stated objective of IPA. It also leans on certain research practices to fulfill this task. Typically this includes research questions that hinge on verbs like exploring, investigating, examining and eliciting (Smith et al., 2012). The IPA researcher normally seeks out a small, mostly homogenous sample, and conducts in-depth, semi-structured interviews, which can be described as “a conversation with a purpose” (Smith et al., 2012). The goal is to let the participant’s meaning making process come to the fore through gentle prods and opportunities to expand. Interviews are recorded and then transcribed verbatim, and the researcher then plunges into several deep readings and rounds of coding for themes and particulars. Pursuing unexpected turns of thought or surprising insights plays an important role. The analysis, in turn, commonly proceeds from identifying the particulars of each account and then to the shared features of the whole, from the descriptive to the interpretive, and with a commitment to understanding the participant’s point of view (Smith et al., 2012). And while the researcher cannot entirely bracket her preconceived notions, she seeks to keep her professional opinions absent from the interaction. The participant’s account should assume center stage. Interview questions are open-ended, providing a starting point for the participant, and should not be leading. Prompts should make clear to the participant that there is ample time and space for elaboration. By authoring carefully worded questions and using subsequent interviews to refine them, the IPA researcher proceeds through the hermeneutic circle. Every new account provides a fresh opportunity for the process of meaning making to unfold—a sense of a problem becoming revealed.
The outcome sought by this IPA study was to reveal how faculty arrive at a decision to adopt technology to change their teaching practice, and what this change means to them. Their successes, regrets and lessons learned can inform the professional practice of colleagues, the design of future learning technologies, and the policies of administrators seeking to promote innovation in teaching and learning. It yielded insights on certain attitudes and habits of mind that contribute to successful teaching practice. Similarly, the fact that faculty in this study are attempting to teach principles and skills of an emerging field, data analytics, could also inform future studies on how working professionals make sense of pressures to adapt to rapidly changing workplace demands. This is a topic garnering significant attention in nearly every aspect of professional life, as technology continues to change the way people work and interact.

Setting

Northeastern University is a private R1 research institution founded in 1898 in an urban setting in the Northeast region of the United States. Its first classes took place in the adjacent YMCA on Huntington Avenue, and it functioned partially as a settlement house, providing professional education in law and engineering to immigrants. In keeping with this tradition, it is known for its emphasis on experiential learning, as it places students in professional internships via its co-op program, through which students gain practical experience in their field of study.

Northeastern University’s undergraduate enrollment is approximately 18,000 students, with an additional 7,000 graduate students. Its most highly-enrolled programs include business, engineering, health sciences and homeland security. In addition to its home campus in the Northeast, it has satellite campuses in Charlotte, Seattle, Silicon Valley and Toronto. It consistently ranks as a top 50 National University by U.S. News & World Report.
The D’Amore-McKim School of Business was originally found in 1922, and currently has enrollments of approximately 3,500 undergraduate students and 800 graduate students. The HUB of Data Analytics Education was formed by professors of accounting within the business school, who sought to provide an open educational resource for instruction in data analytics. Its website includes downloadable data sets and case studies for performing analyses using data analytics visualization tools. Instructors can register on the site and obtain access to these digital learning materials for use in secondary and higher education classrooms. Because most instructors who access the site work outside of Northeastern University, all correspondence with participants took place via virtual communication channels (telephone, email and BlueJeans web conference).

Participants

IPA research, because of its idiographic focus, typically targets smaller participant sample sizes. The purpose is to conduct a deep dive into individual experience, rather than a survey of shared attributes across a large population. The participants were selected purposively, according to Smith et al. (2012), with an eye for homogeneity. This specificity relates to the inductive logic of IPA and contributes to the applicability of findings. Access to participants is typically generated through referral (via gatekeepers to certain individuals), opportunities (via personal or professional networks), or snowballing (referral via participants who have already been recruited). In this study, the researcher used a referral to access participants, as the founders of the HUB of Data Analytics Education agreed to share their list of registrants with the researcher and allow him to contact participants for the study. With the aid of this list of registrants, the researcher identified full-time faculty at four-year, degree-granting higher education institutions, who sought to incorporate an open educational resource to teach data
analytics in their classrooms. The participants in this study sought out the teaching tools of the HUB of Data Analytics Education of their own volition, rather than through departmental directives.

According to Smith et al. (2012), the recommended number of interviews for an IPA study in a professional doctorate program should range from 4-10, presuming approximately four participants interviewed twice. In this study, the researcher interviewed seven participants, twice each, for a total of 14 interviews. Other IPA studies that have explored the experiences of professionals in a higher education setting have ranged from five participants to ten (Meyers and Bagnall, 2017; Dickens et al., 2017; and Wood, Farmer and Goodall, 2016). Smith et al. (2012) argue that meeting the idiographic commitment of IPA becomes more problematic with sample sizes that are “too large” rather than “too small,” as the researcher risks becoming awash in an excessive volume of data. The emphasis of IPA remains on the quality of data, not quantity.

**Types of data**

After participants were identified and their consent to participate obtained, the researcher conducted semi-structured interviews with each, in order to mine their experiences in adopting, implementing and making sense of the change process. These in-depth interviews, supplemented by a follow-up, member-checking interview, provided data for IPA analysis and ensured accuracy of transcriptions.

**Procedures**

The researcher obtained Institutional Review Board (IRB) approval from Northeastern University to conduct this study. After consulting with the HUB of Data Analytics Education team to identify participants that met the study’s criteria, the researcher contacted potential
participants via email to solicit participation in the study, detailing its purpose and the time commitments of participation (Appendix E). It also indicated how data will be handled, how identity would be anonymized, and disclosed that responses may eventually be published within research repositories discoverable on the internet. After agreeing to participate, participants were emailed an informed consent document detailing their rights as a participant (Appendix F). This document was authored in accordance with standards at Northeastern University for IRB approval. The researcher reminded the participants of the same rights and of the purpose of the interview at the start of the interview. The goal of each interview was to encourage the participant to speak openly about their experiences, and questions were rephrased and prompts deployed to support this interaction. Initial questions were authored to solicit open-ended responses, and the researcher sought to abstain from leading the interviewee toward preconceived notions or offering his own professional opinions.

Because participants worked at campuses outside of Northeastern University, interviews were conducted via web conferencing tools, with audio and video features turned on, and a recording of each interview downloaded in mp4 video file format. The web conference tool used was Blue Jeans, and a link to the meeting was sent to the participant in advance of the meeting with support materials.

In-depth, semi-structured interviews lasted 60-90 minutes. The content of these interviews was prompted by the interview protocol (Appendix G), but the primary objective was to allow the participant to reflect and opine on their experiences of the phenomenon in question. Follow-up interviews lasted approximately 30 minutes, and provided the opportunity for participants to confirm the accuracy of the initial interview transcript and provide clarification of their responses. The researcher interviewed seven participants twice, for a total of 14 interviews.
Interviews were transcribed verbatim using a third-party transcription service. The researcher reviewed the audio and video recordings to annotate the transcript for non-verbal cues of significance. Transcripts were organized and analyzed within Word, with notations both for descriptive summaries and the participants’ interpretive activity.

**Data analysis**

Smith et al. (2012) recommended a six-step process for the analysis of semi-structured interview transcripts. They argued that it is not so much a recipe, but a roadmap to help researchers remain focused and organized as they immerse themselves in participant accounts. In general, the idiographic commitment of IPA requires researchers to move from the particulars of individual accounts to shared features, and then the hermeneutic circle returns the researcher from the whole back to the parts, in a reflexive exercise of continual interpretation.

Step one involves reading and re-reading the interview transcript in a line-by-line analysis of utterances. The researcher records first impressions to bracket them, remaining wary of the temptation to make snap decisions on themes and categories based on personal and professional experience. The goal is to let the text of the transcript take center stage. And the initial notes should be identified as such, so that the researcher can revisit and revise them in future readings.

Step two represents the process of initial note taking. Smith et al. (2012) identified three progressively analytical types of commentary for this process: descriptive; linguistic and conceptual. Descriptive commentary is devoted to a literal interpretation of the text, taking utterances at face value. Here the researcher focuses on what was said. Proceeding to linguistic commentary, the researcher pays attention to word choice and the use of idiomatic expressions.
The focus is on how the participant chose to speak about her experience. Lastly, conceptual commentary pursues a deeper meaning in the utterances, looking for an overarching thrust, preparing the researcher for the next step of analysis.

Step three marks a transition from the transcript as the sole focus of analysis to that of the initial notes. By surveying and analyzing the notes, the researcher aims to discover emergent themes. The transcript remains an important part of the analysis, but the organization of themes into a richer interpretive structure is the goal. The emergent themes elicit associations across the transcript, pulling together common utterances.

In step four, the researcher aims to organize and make connections across the emergent themes in order to form superordinate themes. The researcher may employ several strategies to establish superordinate themes, including abstraction (combining like themes with like themes under a new superordinate theme); subsumption (when an emergent theme itself becomes a superordinate theme, subsuming other themes); polarization (when a superordinate theme suggests another superordinate theme as its opposite); contextualization (when emergent themes are organized by an event in time and space); numeration (when emergent themes are organized by the frequency in which they occur); and function (when emergent themes are organized by a participant’s attempt to portray herself in a certain light, i.e. victim or hero) (Smith et al., 2012). During this process, it is also possible to maintain a researcher diary to document the thought process as superordinate themes come together, and Smith et al. (2012) suggested building text documents organized by superordinate themes, in which all extracts supporting individual themes reside.
Step five involves a “rinse and repeat” for the next case, requiring all of the first four steps. However, the researcher continues along the hermeneutic circle in attending to themes that may carry over and apply to the new case, but also retaining the idiographic commitment to the particularities of individual accounts.

After attending to all cases, the researcher proceeds to step six. Here the researcher attempts to identify patterns across cases, negotiating convergence and divergence. The researcher may want to document what the threshold is for a theme to become superordinate across cases. In some situations, the theme may appear in just half of the case. In others, it may appear in all. Whatever the accounting, a rich write-up of IPA data provides evidence for shared themes while also calling out the unique characteristics of individual accounts. And the discourse moves beyond merely descriptive accounts of the data to a more nuanced and interpretive narrative.

**Ethical Considerations**

Given that the participants discussed a change in their professional practice, it is unlikely that the public disclosure of their statements could bring them any bodily or psychological harm. However, professional environments are rife with internal politics, so it was important to advise participants that their identities, statements and the professional organizations at which they work will be protected by anonymity and pseudonyms.

In keeping with normal research practice, participants were informed—through the informed consent form and again at the start of each interview—that they reserve the right to opt out of the study at any time during data collection. In service of transparency and to better prepare participants ahead of the interview, a copy of the interview protocol was provided in
advance. Follow up interviews also provided an opportunity for participants to confirm the accuracy of the transcript, and to clarify any potential misrepresentations of their statements.

To maintain the security and recoverability of recordings, transcripts and supporting documents, all files were saved to a password-protected hard drive, network drive and cloud storage service. The password was known only by the researcher. Transcripts and the final write-up used pseudonyms, and participants were asked not to disclose their identity during the interview.

**Credibility and Validity**

Because quantitative and qualitative research have different aims, it makes sense that they would be evaluated for quality and validity differently. Quantitative research obtains validity in that it is replicable. Following the same methodological steps with the same research sample should yield the same results. However, in qualitative research and IPA, the interpretive and idiographic commitments are likely to yield varying results depending on the researcher’s priorities and analysis. This means that it is unreasonable for findings in qualitative research to be replicable, but it does not close the door on validity, with which many qualitative theorists have concerned themselves. Qualitative research can be evaluated for quality and validity without making claims to replicability.

Smith (2010) argued that quality IPA research often shares attributes across studies. It was previously mentioned that IPA research is a very “writerly” activity, and much of the categories of quality IPA work are drawn from how the researcher articulates and supports the analysis. According to Smith (2010), trademarks of a quality IPA paper include: a clear focus;
strong data; rigor; sufficient elaboration of themes; analysis that moves beyond descriptive to interpretive accounts; negotiates divergence and convergence; and is carefully written.

Theorists like Smith have also pointed to Yardley’s (2000) categories of good qualitative research. Yardley argued that such research includes a sensitivity to context, both within theory and prevailing literature and within the participants’ sociocultural setting. Quality research demonstrates commitment and rigor, in the sense of a deep engagement with the topic, thorough and competent data collection, and logical analysis. It bears transparency in data presentation and coherence in argumentation. Lastly, it demonstrates impact in contributing to existing theory and importance in shaping future practice (Yardley, 2000). So, while the qualitative researcher’s prerogative may not be replicability, issues of credibility and validity remain front of mind.

Maintaining a clear and discernible train of logic from theory to method, data collection, analysis and, ultimately, to argumentation, remained paramount.

Validity in qualitative research is primarily obtained through these measures of quality. Transparency in all stages of the research also helps to lend credibility. In addition, this study employed member-checking in the follow-up interview. Sustained engagement with participants and clear articulation of the expectations of each interview assisted in building rapport and setting participant and interviewer on equal footing.

Lastly, because of the idiographic focus of IPA and a commitment to investigating both convergence and divergence, IPA makes more nuanced claims on transferability. Lincoln and Guba (1985) argued that a form of transferability can be achieved via thick description, or detailed accounts of field experiences and participant utterances, which establish patterns. Thick description enabled the researcher to draw inferences for other, similar cases through a
preponderance of evidence. Thorough documentation of interviews, coding, analysis and a researcher diary in this study helped build an audit trail to establish transferability.

**Reflexivity and Potential Researcher Bias**

Being able to identify my own interactional habits and personal and professional preferences is an important part of IPA research. While I could not fully bracket them, because they play a large part in my interest in the research topic, remaining aware of them helped me to recognize when they might steer interviews and analyses. My principal research interest focused on how faculty in higher education negotiate and arrive at decisions to adopt technology in their teaching, and how their creative work in this field can be communicated to peers to influence practice at the organizational level. In my professional work, I am tasked with training and supporting faculty, and with designing course content that transitions faculty from pure lecture-based models to a more digital, interactive and experiential pedagogy.

My position in relation to this problem elicited potential scenarios for bias. As defined by Machi and McEvoy, I am likely to exhibit a number of “predispositions to certain conclusions” (2016). Some of these may be based on personal attachments to methods of course design and practice. They may also be based on beliefs of what technology can accomplish in providing an effective learning experience. While administering interviews, it was important that I abstained from inserting my professional opinion into the conversation. For instance, professionals in education technology often hold certain assumptions—namely, that technology provides greater benefits to students and helps them to learn; that in many ways it is better than so-called “traditional” methods of instruction; and that because it is new and different, it represents the “future” of education. These biases represent trends in the field which both the participant and
interviewer may be aware of, yet could unwittingly shape the direction of the conversation to signal competence or “with-it-ness.”

That said, the bias of a technology advocate can also “illuminate inquiry,” as noted by Roulston and Shelton (2015). Because the inquiry is motivated by a certain purpose, it is grounded in real-world application and experience. But despite the bias, the researcher has to be prepared to provide a rationale for the study. Fine wrote that researchers “need to interrogate why they are studying what they study; what in their own biography, curiosity or sense of responsibility spurs the questions asked” (2006). Fine advised that researchers confront their own anxieties and fears, the “who-am-I-to-do-this-work.” One of my chief anxieties is that while my work may support changes in teaching practice, I seek evidence for whether it has changed teaching practice for the better. So the question arises not only how I have affected change, but to what effect? This problem recalls the pro-innovation bias of IDT, or the assumption that once the chain of adoption is set in motion, diffusion is a foregone conclusion. To avoid this, I sought to author interview questions that did not lead the participant down this path. Rather, it was up to the participant to assess the value and purpose of their work.

I shared office space with faculty and staff who have designed the data analytics curriculum under study, and as a colleague I am a supporter of their initiative. I found their work to be an interesting method of producing digital learning materials that target a highly sought after skill in the labor marketplace. The initiative sought to provide access to and impart 21st century business skills that otherwise would be obtainable only through corporate internships, the fairly exclusive niche of the well-to-do and the well-connected. As a researcher, I wanted to know how the faculty adoption experience can inform comparable initiatives in the future, so that administrators and faculty can design similar programs with better supports for adoption and
greater impact. But when interviewing participants, I tried to avoid giving the impression that the decision to adopt is a “good thing.” Or that participants are consulting on the project. Instead, I wanted to understand how participants negotiated the decision and made sense of it. Prompts that reoriented participants toward their own perspective will served to prevent excessive editorializing or cheerleading.

A final thought relates to the bigger picture of how people relate to their work, and what increasing automation in the workplace means for this. The willingness to change how one works is important, but even more so to be able to evaluate skills development and technology adoption strategically. It is no longer the province of conspiracy theory to argue that without an honest accounting of the proper balance between humans and technology in the workplace, great ruptures in society are likely on the horizon. The current political climate could lead one to conclude the signs are already here. And ultimately, when the day comes that demand for a job or a skill set dries up, how does a person set about learning to work in a different way? How do we train people to be perpetual learners—to become more adaptive to the sometimes heart-wrenching process of change? This is a larger challenge, within which the adoption of technology for teaching and learning will most likely play a significant role. But it is up to the participant to determine if this trend is important to them.

**Limitations**

This IPA study had a number of limitations. First among these was the unlikely possibility of finding a truly homogenous sample of participants. Because the participants were recruited from institutions outside of Northeastern University, they exhibited some key differences in their home institutions (private versus public) and professional status (tenure track versus non-tenure track). They were also at different stages in the adoption process of the open
educational resource under study. IDT theory also makes assertions about the characteristics of adopters in different stages, which may be informative, but should not restrict the interpretation of data. These limitations do not undermine the validity or transferability of the study, but the variables of participant contexts may or may not be at play in the sense making process, and the study can only make modest assertions about their role.

Similarly, because of the idiographic commitment of IPA methodology, the goal is not to find any essential features of the experiences of participants, although there will be opportunities to identify and elaborate on shared characteristics. These shared characteristics may or may not be transferable to other cases in similar contexts. What is important is that the shared features contribute to informing potential challenges in similar projects. But they are not to be taken as “proof” for any particular course of action. This tension is a natural outgrowth of IPA. Wagstaff et al. (2014), in a study of eight IPA researchers, found a common experience in the "uncomfortable dualism" between "theme" and "idiography" (p. 11). Proceeding along the hermeneutic circle, the IPA researcher hopes to allow particularities to shine through while also identifying themes that are shared. We are as much concerned with the unexpected and surprising features as the commonplace and obvious. But the particularities may be as informative for readers as the themes, given that researchers and practitioners all inhabit their own individual contexts. What is resonant for readers may be as unexpected as the particularities of individual accounts.
Chapter 4: Findings and Analysis

This study examined an initiative at the researcher’s institution to provide an online open-source data analytics curriculum for instructors of accounting courses to use for teaching at their own universities. The purpose of this interpretive phenomenological study was to understand the decision-making process of instructors adopting an OER, and what rationales and motivations drove them to adopt. It used semistructured interviews to explore their experiences of adoption, and also paid close attention to their efforts to spur diffusion of the tools they adopted across their institution. Analysis of the interviews yielded three superordinate themes and 11 subordinate themes.

Table 1

<table>
<thead>
<tr>
<th>Superordinate Themes, Subthemes</th>
<th>Andrew</th>
<th>Bernard</th>
<th>Christopher</th>
<th>Derrick</th>
<th>Elizabeth</th>
<th>Fiona</th>
<th>Gwen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Teaching for a changing profession</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Constraints of the accounting curriculum</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>b. The role of automation</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>c. Listening to firms</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>d. Evaluating tools and programming languages</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>2) Charting a new path as an instructor</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Changing the approach to teaching</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>b. Learning alongside students</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>c. Seeking resources and training</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
The first superordinate theme was *Teaching for a changing profession*; it had four subordinate themes: (a) *Constraints of the accounting curriculum*, (b) *The role of automation*, (c) *Listening to firms*; and (d) *Evaluating tools and programming languages*. The second superordinate theme was *Charting a new path as an instructor*; it had three subordinate themes: (a) *Changing the approach to teaching*, (b) *Learning alongside students*, and (c) *Seeking resources and training*. The third superordinate theme was *Discovery to implementation*; it had four subordinate themes: (a) *Institutional environment*, (b) *Testing and troubleshooting*, (c) *Customization*, and (d) *Influencing peers*.

**Teaching for a Changing Profession**

All but one participant recounted having worked in a professional accounting role before becoming a college-level instructor. They were unanimous that the accounting profession had changed significantly over the course of their careers. This presented challenges as they sought the best way to teach for a changing professional landscape. They faced the problem of teaching within a tightly controlled curriculum, with many courses mandated to satisfy industry standards and CPA certification. Instructors noted that the large amount of content that needed to be covered led to curricular and time constraints on adapting their instruction. Instructors also talked about the role of automation, which was eliminating the human role in more rote accounting tasks. This presented a conundrum: students needed to develop an understanding of the rote tasks...
of the accounting profession in order to obtain competence in higher-order tasks, even though they would never perform the rote tasks manually in the field. Instructors also struggled with the process of collecting information from accounting firms about what students needed to know. The information was often plentiful, yet disparate and firm-specific; this made it challenging to decide what to teach. Instructors could easily conclude that teaching technical skills in data analysis was important, but they then still had to determine which tools or programming languages to teach, what could they reasonably expect from their students, and how much time to devote to these tools. There were four subordinate themes under the superordinate theme

*Teaching for a changing profession:* (a) *Constraints of the accounting curriculum,* (b) *The role of automation,* (c) *Listening to firms,* and (d) *Evaluating tools and programming languages.*

**Constraints of the Accounting Curriculum**

A common refrain among the participants was that the amount of required content in an accounting degree program left them with little flexibility to introduce new content. This was a consequence of teaching in a professionalized field with a large number of industry standards. Furthermore, most instructors were the sole faculty member in their department teaching topics in data analytics, or at least teaching using tools and environments beyond Excel. Typically, they taught this material as an elective or in a one-credit lab. Most participants also believed that the courses required for degree completion and CPA certification provided limited opportunities for introducing concepts in data analytics. There was simply too much material to cover within the programs as currently designed. Bernard noted, “The tough thing about the accounting curriculum is that…the profession is so regulated that accounting majors have an enormous amount of required courses relative to other majors.” Gwen noted this same problem from an accreditation perspective:
Our challenge is when you look at the state board requirements for CPA… So the Texas state board, which licenses CPAs in the state of Texas, does not approve or allow you to use a lot of technology classes for your required accounting course work. This issue led to tension between preparing students for the CPA and developing technology skills in data analytics. Each could aid the other, but instructors strained to build a path for consistent data analytics skill development across the curriculum. Because of the large number of required courses, electives typically are taken towards the end of a degree program, sometimes when a student already has a job offer in hand. An elective in data analytics may prove useful, but its challenging content acts as a disincentive for a student to take that course when on the verge of graduation and initial employment. Elizabeth viewed the rigidity of the accounting curriculum with almost non-plussed amusement: “Um, so with accounting, because we have such a, we do have a very tight curriculum. I think the students can take like two electives or something ridiculous (laughs).”

Regarding teaching data analytics with colleagues, Derrick said, “Some faculty may say, ‘oh, I want to do that.’ But it’s not really easy for some courses like, say, financial accounting, because there’s so many sections and there’s so much content that has to be covered.” Bernard echoed Derrick’s assessment: “Largely, you know, you can’t change a Principles of Financial Accounting course too much, and make it too data centered. You’ve still got to teach debits and credits, right?” Here we see that the content of a particular course may not lend itself to incorporating data analytics tools. This is likely the reason that most topics in data analytics are taught in one-credit labs, electives or as part of audit and accounting information systems courses.
Concerns about rigor emerged along with those about fit. Andrew said he tried to maintain rigor in the data analytics course he taught, “but I haven’t pushed them [the students] quite as far as I would have if it were a required course.” This issue is not unique to the undergraduate accounting curriculum, but instructors struggled to identify where and to what extent they should introduce concepts in data analytics. Fiona said, “Sometimes I want to put in more than is practical for the students to accomplish, so sometimes that’s probably my bigger struggle.” Instructors sought to balance fairness in expectations against their own observations of which skills were demanded in the field. We can observe them negotiating a situation in which little flexibility exists, and thus their efforts can take the appearance as one-off exposure for students, rather than a comprehensive effort at skill development.

**The Role of Automation**

In addition to the constraints of the accounting curriculum, participants spoke about the role of automation in the field of accounting. Firms are increasingly using automated processes to conduct many tasks that were historically completed by entry-level accountants. Instructors grappled with the challenge of teaching the fundamentals of accounting, which prepared students for the bulk of entry-level work, but also using these lessons as a stepping stone to higher-order critical-thinking skills. The fundamentals would help students understand the underlying principles of the processes being implemented and then be able to productively analyze the data they were managing.

Christopher spoke directly about the input he collected from Big Four accounting firms on this topic:

They’re making a lot of investments trying to automate a lot of the entry level processes, where we used to send our students. And one of the messages that we’re getting…is that,
“I don’t want the student who can do entry-level data entry or some of the basic stuff, because this is the kind of job I’m already in the process of automating.”

This is an example of pressure from the field to teach beyond the fundamentals of the traditional accounting curriculum. Bernard added:

Our students are increasingly being expected to have certain technical skills when they leave… And so, I just see it as responding to the market and that’s kind of what our, what our job is to do, to set up our students for success.

Participants echoed this sentiment throughout their commentary, but noted it was not entirely clear how to arrive at higher level skills. Andrew noted that he struggled to predict what students would need to know for the profession five or 10 years down the road, but he sensed what was coming:

Less entry-level work, less rote tasks, more higher-level tasks. The big question for all the accounting firms is how do you get people at that middle level, who have the judgment and the knowledge to do the higher-level tasks, if they’re not doing the lower-level tasks first?

This pressure to achieve a higher level of competency in accounting raises expectations for both students and instructors. It also leads to a greater emphasis on analytical and critical thinking skills. Elizabeth stated:

The expectation for those critical thinking skills is going to move up, where students are gonna have to be able to think critically about business process and risk and, and things on day one. There’s gonna be a higher level of expectation of what they bring to the table when they start working.
Derrick argued that automation would not replace accountants, but instead would change the nature of their work. Some of the participants noted that accountants would become less like gatekeepers and managers of data, and more like analysts, interpreters, and consultants. According to Derrick, even if accounting data-entry work is automated, “You still need somebody to make judgments about that data...and to advise clients. So there’s still going to be demand for higher level...critical thinking, judgment, (and) analysis.” Introducing students to data analytics tools and skills, according to the instructors, helped expose them to the new types of skills required in a changing profession.

Fiona and Gwen commented about what these increased expectations mean for the instructor side of teaching and learning. They raise the stakes, and they also make the job of the instructor more difficult because assessing higher order thinking skills requires more effort on the part of the instructor, via open-response questions and class discussions. These types of assessments are not easily automated and require greater cognitive effort from the instructor to provide feedback. According to Fiona:

It makes, I think, our job harder because of the grading aspect of it, because, you know you can’t use really multiple choice, because that’s not real, truly, I mean some of it, you can still do some critical thinking with multiple choice, but you still have to do a lot more free response and application.

She believed that examinations in which students have to deal with ambiguity and be creative in problem solving were better assessments of critical thinking skills. In many instances, there is no one right answer. Gwen argued that in this new paradigm where students enter the field beyond the level of data entry, they have to understand both the process of journal entries (even if they will never make them) and also how to spot issues when the process goes awry. Gwen stated:
So they [students] enter accounting in the field now more as a review or reconciliation step as opposed to data entry clerks. And that’s where we have to teach them all these fundamentals, which is hard, and then also show them how do you get past those fundamentals to review the data.

No participants suggested a silver bullet for achieving critical thinking skills, but they did emphasize staying on top of the field, consulting with recruiters, and providing exercises derived from professional context that kept an eye on the big picture. Andrew said, “I lose sleep at night over what do my students need to know five years from now, because we need to start teaching them that today… [But], uh, I don’t know, I don’t have a great answer for that.” Most participants acknowledged that if students’ first jobs had a greater resemblance to an analyst or consultant role, then instructors would have to generate more assessments testing their ability to deal with ambiguity and be creative. This, they hoped, would add value in a situation where the previous entry-level role of data entry clerk had been subsumed by technology.

**Listening to Firms**

In selecting OERs and technology tools to teach data analytics, instructors frequently consulted with accounting firms to discover what qualities and skill sets they seek in the graduates they hire. While constraints on the traditional curriculum and the role of automation can be obstacles, an impressive amount of collaboration exists between accounting firms and the academy. Curriculum committees stock advisory boards with practitioners and recent alumni working in the field. Recruiters make frequent campus visits and correspond with faculty. Firms make presentations on campus, invite faculty to training events, and publish white papers and teaching cases. Instructors, for their part, maintain networks with former colleagues in the industry. Even so, the information faculty receive can be disparate and often depends on the
context of individual firms. This consistent feedback loop informs faculty who seek to teach data analytics.

Derrick described having the widest variety of information sources from industry. He mentioned representatives from industry who served on advisory boards, relationships with former colleagues, and workshops and webinars hosted by firms. Regarding the latter, he said, “I might attend a webinar and say, ‘Oh, this is being used,’ and share with my colleagues. And we’ll discuss it.” Elizabeth relayed a similar experience:

An instance where I’m able to connect with somebody from public accounting is when I’m asking the questions, “OK, what are you using? Um, you know, what kind of technology are you using to support that?”… And I’ve, I’ve found that it’s given our students an advantage when they are, you know, in internships, and they have a leg up over their peers because they at least had some exposure to it.

Andrew shared that he would visit online faculty portals managed by Big Four accounting firms and sometimes incorporate them in his teaching. He felt the OERs were of high quality for teaching data analytics. Other instructors felt the quality of the materials was up to par, but that they were still emerging compared to what was available for teaching the traditional accounting curriculum. Instructors valued their contacts in the field to help supplement the curriculum.

Even when they obtained quality information from firms, instructors noted that they felt they had to evaluate it through an interpretive lens, since it was often disparate. The technology tools and skill sets sought out by accounting firms could vary firm to firm. Bernard explained it this way:

The profession hasn’t really adopted a standardized set of tools or techniques. Everyone’s still trying to figure this out… So we’ll, we’ll have one Big Four accounting firm that has
released a white paper on what they want students to know, and it’s highly technical. So specific software packages, specific techniques. And then another major firm, a Big Four firm, similar market share, says, “we don’t want you to know these techniques, we just want you to, uh, have an intellectual curiosity…know how to write, know how to be a good public speaker, and don’t worry about learning a specific programming language.” And these are two of the top four firms asking for completely different things from students.

Gwen also noted that the information she receives from firms can vary firm to firm. She believed it depended on the firm’s size:

The big firms, the Fortune 500s, the Big Four, you know, Big 10 accounting firms, they’re using that technology and trying to be the leaders. Your small CPA firm has got 15 people in their office, you know, they’re just struggling to stay afloat and make sure they’ve got enough staff to get through the audit or the tax return. So, um, so it’s very disparate, but it’s based on the size of the firm.

The variety of information received from firms requires faculty to make crucial decisions about what to teach and about what amount is reasonable for students to absorb.

Instructors must make these decisions around the information they have collected, especially when it points in several different directions. Fiona said that one takeaway she was able to identify, while serving as the liaison between an industry advisory board and the curriculum committee, was developing a comfort level in working with technology. Referring to the people she had spoken with in the industry, she said, “Overwhelmingly, most of them said that they just wanted them [students] comfortable with technology, because it’s always changing so rapidly.” Bernard came to a similar conclusion:
As far as, you know, being able to pinpoint like very specific technical skills that students will need five years from now, I just…I don’t know. Um, because, I don’t think the firms really know yet. And so I would say there’s gonna be a greater focus on data, a greater focus on technology, um, but beyond that, I think I’m still trying to figure that out and I think a lot of us are still trying to figure that out.

Christopher stated, “I don’t know if this makes sense, [but] I prefer that we spend more of our time preparing for the changes that will come instead of trying to think of what will be the changes that will come.” He was arguing that instructors had to collect information from industry to stay current, but they could not teach for every professional context nor predict the future. An emphasis on building skills with some measure of transferability became the default among the instructors. They hoped this would make students more competitive and adaptable in a professional environment. Similarly, participants noted that firms may not know what tools or skillsets they will need in five years. In many ways, firms are looking to instructors and students as working in a laboratory, hoping they will generate tests and solutions for existing problems in the field.

**Evaluating Tools and Programming Languages**

Once an instructor has sought input from industry professionals on the types of tools used in the field, the next task is to evaluate those tools and programming languages to determine which ones they should teach in their courses. All participants used the dataset produced by the HUB of Analytics Education to teach data analytics for accountants, but they diverged in which software packages or programming languages they selected to teach data analytics. Around half of them decided to teach a programming language, while the other half opted to teach with a software program. Nevertheless, all participants evaluated and selected tools in a similar manner.
They sought to manage their time effectively while evaluating tools and training themselves on how to use them. They sought solutions that were free or low-cost for students, with favorable and portable license terms. They sought to impart transferable and relevant skill sets, given that most students might use a different tool or programming language in their jobs. Finally, they wanted robust teaching and training materials, so they would be supported by the tool provider if they ran into problems and would not feel they had to start from scratch.

All participants mentioned the cost of licenses to students as a driving factor. They did not want to add costs to students as they learned data analytics. Fiona said, “I kind of look for things that don’t cost anything, or cost minimal. You know, trying to keep the cost down for the students, so that they’re not having to pay for too much.” Andrew said he repeated a question to himself when evaluating tools. “What is each of these things gonna cost the students? Is it worth the benefit?” Speaking about the bulk of the materials in his data analytics course, he preferred content and tools that were free and open source. “Nearly everything that we do in this class is open in the sense that it’s publicly available. So whether it’s on YouTube or these, uh MOOCs that the students are doing are publicly, they are open to the public.” Because the instructors were introducing new materials to the students, there was a sense that they did not want students to feel they had to invest financially to partake in a curriculum change that, at least initially, could appear experimental.

Instructors also were very aware of the marketplace for data analytics tools. Most tool providers are eager to provide free licenses for classroom use because they have an interest in creating a critical mass of accounting graduates well-versed in their tool. This induces employers to purchase licenses for the tool in which the labor force is well-trained. This same logic drives the companies to compete for exposure to instructors and students in university classroom
settings. Instructors cited the ability to have software installed on both lab computers and students’ personal computers as an important factor. Bernard stated, “A big deal for me is can my students load the software on their own laptop, right?” Elizabeth reinforced this sentiment, citing an instance in which it was a determining factor in her decision to adopt. In comparing ACL to IDEA, two different tool providers, she said:

I find IDEA very user friendly… They provide us with an instructional book, students can download, um a license on their individual PCs that has a record limitation. And they actually provided us with the free corporate version for our lab environment. So, in my opinion, they’re, you know, they’re very supportive.

In this context, restrictive licenses or limited support services could quickly eliminate a tool provider from an instructor’s menu of options.

The availability of prewritten teaching materials, training and support relates to the time constraints instructors face while developing new curricula. Most participants talked about their expectations for training themselves on a new tool and what went into the process. Andrew said the time commitment to research and train himself on a new tool can be significant, but he also learned to parse the core features of a tool quickly:

It’s tough. But, um, I think that’s our job, is you spend whatever time it takes. And, um sometimes, it’s longer…[but] some of these different software products, I might login, I check it out, and after about 10 minutes, I already don’t like it, I’m not gonna waste more time on it.

Bernard spoke similarly, saying, “It doesn’t take that long to kind of play around with them and see where the limitations are, you know, check the availability of a student license and look at the instructor website.” As early adopters of data analytics tools, they admitted to feeling
overwhelmed at first; they developed a better sense of judgment after adopting and refining the process. Elizabeth stated, “There's a process to get there, right? I can’t just decide willy-nilly I’m gonna adopt stuff. We don’t have unlimited resources, there’s, there’s more to it than that. And then there’s also bandwidth, what I can handle.” Instructors were well aware of the cost-benefit and risk factors involved in training themselves on a new tool in order to teach it. While striving to become better teachers, they also became better consumers of data analytics tool providers—and more efficient managers of their professional lives.

There was an interesting divergence among the rationales provided by two participants on whether to teach a software package or a programming language. Andrew opted to teach with Tableau. Christopher eschewed software packages and decided to teach R, a programming language for data analytics. Andrew argued that firms would already have professional programmers on board, so they did not need accountants who could also program. Andrew stated:

So for the accounting majors, uh, what we wanted them to know is, is to be fluent in data analytics and, and understand the concepts, um, but most of them who will be doing this, a lot will be at a Big 4 firm with dedicated programmers, so I didn't want to teach them R or Stata or any of that.

Christopher, in contrast, believed that because he could not predict the software programs that firms would use, it was more important for students to learn a programming language so they could understand the logic operating in the background of data analytics software. He argued that this would make students better prepared to adopt whatever software their firm turned out to use. Christopher said, “The reason that I chose to use R for my classes was I can’t predict what
software your company will be using five years from now.” But, he said, learning the logic within R prepares students for a data role at an accounting company. He continued:

No matter what kind of software they throw your way, you’ll figure it out in a week…

And the reason that you will be able to figure it out faster than anybody else, because you understand the logic behind most of this software.

He also said it would take an instructor five or six weeks of intensive coursework to acquire a basic knowledge of R. Fiona, who taught with both R and another software package, sat in on a data science course for a semester to train herself, and eventually hired a graduate student from that course to teach a module on R in her course. The learning curve on a programming language is steep, and most participants grappled with whether it was worth the time. Christopher came to the problem with more of a data science background than the other participants, so it is understandable that he preferred a programming language. Most participants opted for software that had some industry validation, with sufficient technical and training support for them to quickly acquire the skills they needed to introduce core concepts in the classroom. The shallower learning curve of software programs allowed for quicker uptake and implementation of the tool in the classroom, whereas programming languages required much greater preparation to learn and then to teach.

**Conclusion**

As the accounting profession has adopted a more data-driven approach, instructors of accounting in higher education have been compelled to shift in that direction. While doing this, they have to manage the tight course progression of an accounting degree and the requirements of the CPA exam. The most common response to the constraints of the accounting curriculum has been to develop electives and one-credit labs in accounting information systems and data
analytics. The learning objectives have trended more toward exposure than deep learning. This has reduced expectations about what students can accomplish in an elective or a condensed course, while increasing the need to teach critical thinking skills. The frustration participants expressed over limitations on flexibility in the accounting curriculum was palpable.

Teaching critical thinking skills obtains an added sense of urgency when instructors are confronted by the role of automation in the accounting industry. Large firms are automating many of the fundamentals of the accounting profession, such as journal entries. So while learning these tasks remains essential to acquiring higher-order skills, their value has been diminished, which means there is pressure to spend less time on them. Working on cases with large data sets that yield many different and equally valid analyses requires instructors to become more agile in assessing students. Instructors noted that the exercises they designed to teach data analytics could not be assessed through automated multiple-choice quizzes with one right answer and a few false positives. Students required not only more feedback, but more nuanced and tailored feedback. Instructors also had to design assessments that forced students to deal with ambiguity and stretch their creativity.

To introduce new content in data analytics, instructors leaned on contacts within firms to determine what tools and programming languages professionals in the field were using. Participants noted they often discovered that firms did not know what skills they would need or what tools they would be using five years down the road, and thus their classrooms became laboratories in which instructors and students would have to confront these questions. Participants had to devote time and resources to evaluate tools and train themselves on how to use them. Instructors reported that they began to develop more efficient processes in gathering information and evaluating tools as they gained experience. They also exhibited a strong
preference for tools with less restrictive licenses, that provided cheap or free access to students, and had robust structures for instructor training and technical support. Instructors also had to make a decision on whether to teach a software package or a programming language. Those with a background in data science expressed a preference for programming languages, whereas those with less expertise in data science started with a software package. All of the participants evaluated the tools available to them with an eye for transferability of skills. Instructors could not predict what tools students would be using in their first job, but they could start students down the path toward gaining an understanding of data analytics. This would bolster students’ analytical thinking skills, wherever they landed.

**Charting a New Path as an Instructor**

As instructors collected information on the changing profession for which they taught, it became apparent to them that their approach to teaching would also have to change. While they could not predict the future or forecast what an entry-level accounting position would look like in five years, they knew it would be different. As a result, their classrooms would also have to be different. This research uncovered three subordinate themes within instructors’ journeys to strike out on a new path. The first dealt with how instructors changed their approach. A changed approach implied turning toward a more active and peer-to-peer type of learning, with problem solving and exercises conducted in a lab classroom setting. It created situations in which students proposed questions for which instructors had no immediate answer, requiring them to think on the fly and learn alongside students. It also meant that instructors had to develop into their own mini-expert on the topic, seeking out resources and training, as they were the first in their college to attempt to teach data analytics. In all three of these subordinate themes, instructors shared how they redefined their roles as professors of accounting. The subordinate themes described in this
section include: (a) Changing the approach to teaching, (b) Learning alongside students, and (c) Seeking resources and training.

**Changing the Approach to Teaching**

Participants discussed how the accelerated pace of change in the accounting profession and the continual emergence of new technology pushed them to change their approach to teaching. Evaluating and implementing new tools often yielded new learning contexts, in which faculty realized that they needed to modify their existing teaching strategies. The instructors described striking up cross-departmental collaborations, soliciting peer feedback, developing new technical skills, and using active learning and flipped classroom approaches.

Regarding cross-departmental collaboration, a number of instructors sought support or resources outside their own department. Andrew initiated a conversation with colleagues in the management information systems department to discuss a shared project in which students in data science would work with accounting students on a problem from the perspectives of both an analyst and an end user. Bernard consulted with the IT department to determine what tools would be supported. Fiona sat in on an R class in the computer science department and hired a graduate assistant to help her teach the topic. Elizabeth reached out to the university’s newly hired controller to build class projects in which students supported internal audits. In all cases, the instructors worked to harness university resources to make the classroom experience more experiential and more embedded in real-world contexts.

Some instructors also described using active learning and flipped classroom models for teaching. The active learning approach seemed a natural outgrowth of most data analytics courses occurring within lab environments, where students worked alone or in teams on computers to analyze data and solve problems. Bernard stated:
I've had to change my, my teaching style a lot over the past 10 years as these topics have been introduced. And I, I’ve take, I’ve become much less of a lecturer, uh, and I think much more of a, much more of a coach, a technology coach, right?

He attributed this to the more active learning environment of the data analytics lab classroom. He also said that he had to develop new teaching skill sets that he did not learn in his doctorate program. Derrick, on the other hand, said he encountered active learning strategies in his doctorate program, and tried to incorporate them in his teaching:

There were a lot of kind of active learning techniques that we used in my doctorate program that I have found to be um, more engaging, more interesting than just sitting, listening to a, an instructor, uh, lecture for an hour and a half or two hours, or whatever that may be. Um, so yeah, I, I try to adopt those practices as best as I can.

Both felt they lectured less, and spent more time walking around the classroom, supporting students and addressing questions.

Elizabeth said she recently introduced reflective writing assignments in her data analytics courses, which she found to be helpful. She stated, “I’m having students for the first time ever write a reflection paper for the course and sort of, and it’s really good, it’s eye opening for me, and I’m enjoying reading them because I'm seeing their journey.” She used the reflection papers to better understand where students struggled, information she could use when designing the next iteration of her course. Finally, Gwen discussed teaching undergraduates with a flipped classroom design:

I run it in a flipped model, where they get preclass videos that I record through Echo360, and do some online quizzes so that they come to class already knowing a little bit, and
then we can spend more time in class playing and talking about scenarios and questions, as opposed to me just regurgitating the textbook to them.

Most participants talked about a moment when they awoke to the perspective of the student and the challenges of learning a topic like data analytics for the first time. Many of them spoke of the difficulty of gauging the level of difficulty of their course designs when teaching them for the first time. Active learning environments in which students had ample time to practice and receive just-in-time support helped to close gaps. Christopher spoke of an epiphany he had when he started taking guitar lessons, and how it related to his teaching:

This was kind of an epiphany moment because I realized that I’d never taken a single music lesson in my life. For the first time, I was putting myself in the shoes of my students. I was realizing what they're going through. I was realizing how unrealistic it was for me, when I asked to play uh, let's say, a solo from Pink Floyd the first lesson. That’s the equivalent of some of the expectations that I had before…. The best way to summarize my teaching philosophy and what I tell people now is that, tell me something that you've never done in your life. Start doing it, and after you start doing it, go back to your class. Pick something that you've never done in your life before. Something that will really make you feel humble. And then go back, back to your class. That, that’s my suggestion… And I'm glad that I had this experience because I was, to put it mildly, arrogant, and uh, my expectations were unrealistic before. I look back at notes that I had prepared three years ago. I say, “Ooh, my God.”

An instructor may not necessarily need to take guitar lessons to teach data analytics, but instructors seemed to develop a more acute awareness of the challenge of teaching something that may be new both to them and their students. To get past his expert bias, Christopher began
having a colleague with limited experience in data analytics review his teaching notes. In
general, the experience of learning something new prompted the instructors to adapt their usual
approach to teaching to address the new context in which they found themselves. They also
adopted new teaching styles, tending toward active and flipped models, freeing up time in class
for students to work through problems with instructor support. Classes were led more by
questions posed by students rather than instructors. And Elizabeth’s exercise in reflective writing
provided a salient example of how instructors became more aware of their students’ journey in
learning new, and often difficult, material.

Learning Alongside Students

Part of changing the approach to teaching included addressing new learning contexts in
which the instructors did not exercise as much expertise and control over the classroom as they
were accustomed to. Teaching in active learning environments with new tools meant there was
more ambiguity about how to appropriately use the tools, as well as a degree of uncertainty over
whether they would behave as planned. This created situations in which faculty were not
equipped with ready-made answers for technical problems or student questions, and thus had to
react in the moment, or even admit that the entire class would have to work together on equal
footing to find a solution. This experience equalized the power structure between expert and
novice, which instructors admitted could be sobering to come to terms with.

Most instructors asserted they had an increasing level of comfort with this type of
ambiguity, but they also advised anticipating problems as part of preparing for class. Andrew
said this was really a part of standard practice for good teaching, so it should not throw
instructors off too much:
To me that’s just good teaching practice is anything you ask students to do, you should have done yourself. But I think there’s sometimes an inclination to send students off to do something with software that you haven’t done yourself.

Derrick admitted that he had succumbed to this temptation, saying he often felt comfortable teaching something for the first time if he also felt familiar with the teaching notes by themselves. But if an instructor plans to teach a new case or a new piece of software, he said, “I think it’s critical that the faculty go through the entire thing.”

Bernard said that even after thorough preparation, he had a sense of working on the fly in his data analytics course. “I’ve had to react on the fly because...students think of things in a different way than I do when I’m preparing an activity,” he said. He recounted an instance in which a problem occurred in class for which he did not have a ready answer. He had to recruit his students to help work out a solution:

Okay, and so they were all having an error message, and I was like, what is this error? Like, I, the code looked right but that was the problem. And so we figure that out, and I know now that's a problem and that won't happen again. But again, it’s kind of this head scratching thing where, you know, what’s, what’s going on? You know, why isn’t this working? And you just, you just hope, hope that you figure it out (laughs).

Other instructors supported the notion of recruiting students to address problems in a live classroom. Christopher had students work in groups on the same problem-solving activity, and if issues arose, he would ask the groups what their solutions were. If one group had solved the problem while others had struggled, he would have the group that solved the problem teach the rest of the class. Fiona said she would actively recruit students to explain their understanding of a problem. She said:
Sometimes I’ll just have students help too, because, actually, some of them are just so good at technology, they’re really quick to getting it, and so um, sometimes I’ll work in conjunction, so that I know that they understand.

Here Fiona has acknowledged the strengths of students, and harnessed those strengths to the benefit of the class.

Elizabeth touched on the need for thorough preparation and the fear of appearing less than an expert in class, and also on being able to push forward when this has become apparent. She said:

I mean, just make sure you're well versed. Because I’ve had situations when I wasn’t as well trained as I am now or as comfortable as I am now, where students have sort of shown me up or asked me questions that I wasn’t able to answer. And nothing is more embarrassing than that. And, I mean, and I’m honest with them. Like, I don’t know all, I don't have all the answers. I don’t do it all right. Sometimes they’lI ask me a question, I’m like, “I don’t know. Let’s try it together. Let’s see.”

A situation like this could be humbling for the instructor, but it could also be motivating for the student who is attempting to fill in the gaps to supplement the instructor’s expertise. Elizabeth said that it made her uncomfortable, but she felt that the experience stretched her in different ways.

Gwen talked about gaining confidence with teaching in situations in which she did not have all the answers readily available. She said:

I’m unlike many faculty. I don't mind change. I don’t mind putting something new in. Um, and that doesn’t always work and sometimes it blows up in my face, but that’s life
and that’s the lesson my students get is, “Hey, this is how the real world operates, and we'll see if it works and if it doesn’t, we’ll try something else.”

As the instructors gained comfort in dealing with ambiguity in the classroom, they hoped it would generate a takeaway for students, who could observe and take part in improvisation in real time: be prepared, but also be ready to adapt and to collaborate when life does not go according to plan. The classroom becomes a simulation of a professional setting, in which not all solutions are readily at hand. The participants developed more flexible mindsets for teaching, being able to react on the fly to issues, and allowing students to co-teach and showcase their skills.

Participants related a growing sense of humility as they released some control over the classroom, an experience that also elicited a sense of stretching oneself intellectually.

** Seeking Resources and Training **

When instructors decided to teach a new topic, they began to seek out resources and support services to train on what they would teach. Most participants reported being the first in their department to attempt to teach data analytics for accounting, so they often felt alone in the process. Participants turned to the HUB of Analytics Education website to download datasets and find examples of cases for teaching. They also turned to colleagues in other departments, sought out training from software vendors, and attended faculty events sponsored by accounting firms.

To varying degrees, they spoke of gaining an appreciation for the challenge, of a sense of blazing their own trail, and of being able to explore and engage in self-discovery.

The sense of being alone and blazing one’s own trail in the teaching of data analytics recurred among many instructors. Most participants were the only instructors in their accounting department teaching data analytics, so they did not have colleagues within the department to share the load. Andrew noted, “I’m kind of the only person that teaches it here. So I didn’t have a
team of people that I could go to and say, ‘Hey, what have you done?’ Or, ‘What have you seen?’” Bernard agreed on this point, saying he was the only person at his institution teaching data analytics for accounting. “We don’t have the structure in place to teach this yet, so most folks who are teaching it are kind of blazing their own trail in a way,” he said. An unfortunate result of this situation, according to Elizabeth, was that it was difficult to keep skills sharp without a support infrastructure within her department. This prompted instructors to seek resources beyond their departments.

Resources sought out by instructors beyond their own department included talking to colleagues in other departments, consulting with the university’s IT department, participating in training programs offered by software vendors, and attending events hosted by accounting firms. Andrew consulted with professors in his institution’s Management Information Systems Department to discuss how they approached teaching data analytics. He also viewed training videos offered by Tableau, a software vendor, and gave himself time to pursue a number of different options for tools and approaches. He referred to this process as “a bunch of exploration and playing and self-discovery.” Bernard sought input from the IT department to see how students were learning data analytics in courses outside the accounting department. He did this to avoid duplication in his course design. He also encouraged instructors attempting to teach data analytics for the first time to seek out colleagues teaching at other universities: “Find other folks who are teaching a similar course,” he said, “who you feel comfortable talking with about what you’re doing, and figuring out what they’re doing. And if you can, you can share the burden across your colleagues.”

Other instructors, realizing that the workload could be significant, sought the help of colleagues in computer science and statistics who were already teaching with some of the tools
and programming languages they were learning. Elizabeth invited a statistics professor at her university to teach Power Pivot in Excel in her course. Fiona sat in on an entire semester of a data science course devoted to R, and then recruited a graduate assistant to teach the same material in her class. Reflecting on this process, they talked about what they needed to understand themselves versus what was best to outsource. Elizabeth stated:

I can do some self-instruction, I can read the user manual that I give the students, and I can follow along, but I need to do a little bit of a deeper dive, and I need to understand a lot of the why.

Fiona echoed the need to devote time to gain a higher-level understanding of the tools she was introducing in her course. Talking about the R course, she said:

I asked the professor who I’m friends with if I could sit through his class on Monday nights, and that’s what I did for a whole semester. And kind of learned how to do it. I can’t say that I’m very good at it, um, but I get the concept.

All of the instructors spoke with a similar level of humility in explaining how they went about learning what they planned to teach and the depth of knowledge they could claim thus far. Derrick, who initially tried to teach a data analytics case without seeking training himself, said, “I wish that I had a greater appreciation for how challenging it might be, and, um, needing training on it myself before giving it to the students.” As participants related the experience of feeling alone in the process, they responded by turning to vendor training options and sought input from colleagues outside their department. They also had to remain diligent to keep the skills they acquired sharp from semester to semester. But as they engaged in the process, they reported experiences similar to Andrew’s: “[it’s] a bunch of exploration and playing and self-discovery.”
Summary

As instructors began to redefine their roles in the classroom, they experienced a number of interesting revelations about the process. They began to seek the expertise of colleagues outside their departments in order to see how other disciplines treated data analytics. They re-engineered their classrooms into laboratories, rather than lecture halls, where problem solving received peer and instructor support. A greater emphasis was placed on active learning and a student-driven classroom. One participant included reflective writing as a component of the course, an example of instructors’ heightened awareness of the students’ learning journey. All of the participants cited a noticeable change in the way they taught, given that they had to learn the new content as students, and then quickly change roles to impart it as instructors.

The instructors also had to adjust to an identity shift, in which they were no longer the same authoritative expert figure, but instead were co-learners, only a few steps ahead of their students on the learning curve. This created situations in the classroom where faculty had to admit they did not have a ready answer for students, forcing the class to work collaboratively to discover a solution. Instructors developed a sense of humility in this new context, ceding some control over the classroom, and felt themselves being stretched in the process. Similarly, faculty had to seek resources and training beyond their usual sphere of expertise, consulting with faculty in other departments, professionals within IT, and colleagues at other institutions. These experiences led to opportunities for play, exploration, and self-discovery. All of the instructors viewed their redefined role as an improvement to their teaching practice.

Discovery to Implementation

Participants discovered the HUB of Data Analytics Education through a variety of media. Some were referred to it by colleagues. Most discovered it via presentations at professional
conferences. They were all convinced of the value of a large dataset mimicking a company’s sales transactions that could be downloaded and analyzed using data analytics tools and programming languages. But the path from discovery to implementation was largely individual, even if based on a number of shared factors. The most pronounced of these included the institutional environment the instructors found themselves in, the need to test and troubleshoot whatever tool they selected, the extent to which they customized the materials they adopted, and the desire to influence the teaching practice of their peers once they had successfully taught data analytics in their own classrooms. The instructors responded to these aspects of implementation differently, but they reflect a shared experience in that they had to be confronted in order for implementation to be successful. The following four subordinate themes are discussed in this section: (a) Institutional environment, (b) Testing and troubleshooting, (c) Customization, and (d) Influencing peers.

Institutional Environment

As instructors talked about the concepts and tools they considered teaching, they also spoke about the institutional environment they found themselves in, and the extent to which it facilitated or inhibited their ability to implement new ideas. Because all participants worked at research institutions, it may come as no surprise that they spoke of working with a high level of autonomy, even if their responsibilities were exclusively centered on teaching. They spoke about how they obtained buy-in from their department or found funding from the college. They also spoke of the challenge inherent in developing their own course materials while also working to make technology and analytics education more diffuse across the curriculum.

Two research faculty members, Bernard and Christopher, explained that most of their responsibility was research, but they also had autonomy to teach as they saw fit. Christopher
stated, “The school will not tell me anything. In other words, I have the leeway to implement my ideas.” As they developed new ideas in their approach to teaching, they found that faculty came to them for ideas in teaching data analytics. Their autonomy to strike out on new ground became an asset for the department. Even though their primary responsibility was research, they viewed innovation in teaching as a service to their own work and the institution. Andrew, another research faculty member, said faculty at his institution were primarily responsible for teaching courses in their own area of expertise. This precluded department heads from questioning their teaching practices. He summarized: “Because we’re each in charge of this course, we can do whatever we want. So there’s nobody who’s going to say, ‘Don’t do it.’” This autonomy allowed the instructors to be more experimental in their approach to teaching, which, when successfully implemented, raised their profile as instructors.

Other participants, those who were not on the research track, spoke similarly about autonomy at their institutions, but also touched in greater detail on the incentive structures that supported innovative teaching practices. From evaluations to departmental buy-in to funding, they described administrative support in a favorable light. Derrick spoke of a structure in which most curriculum materials were standardized, but the director of his program allowed him some flexibility to teach data analytics with Tableau. He also felt that as a primarily teaching faculty member, it was in his self-interest to improve his teaching. Elizabeth said that funding was not always easy to find because she worked for a state institution, but she was able to obtain funding for multi-day training sessions for herself if she needed it. She noted that, in addition to funding, she had to be cautious about how many new projects she could add to her teaching plate. “I can’t just decide willy-nilly I’m gonna adopt stuff,” said Elizabeth. “We don’t have unlimited resources, there’s, there’s more to it than that. And then there’s also bandwidth, what I can
handle.” So while support existed even in tighter financial environments, faculty had to be wary of overextending themselves.

Fiona and Gwen also worked at state-funded institutions. Fiona reported that the dean of her business school was very supportive of introducing technology and data analytics in the classroom, and said she never struggled to find funding for training or guest speakers. Gwen found her business school to be one of the more innovative colleges on campus. She said there were no mandates from the dean’s office to adopt certain practices, but she felt encouraged to implement new teaching practices she had developed. Gwen stated, “If there’s a new process, a new procedure, one that relates to recruiting students or student engagement, the dean is always 100 percent, ‘Let’s go do that.’” Instructors placed a high value on having the autonomy to change teaching practices and receiving support from administration to do so. But this also presented challenges when instructors served on teaching and curriculum committees at the college or university level. Suddenly, they found themselves wearing the hat of the administrator.

Once instructors had developed tutorials and cases for teaching analytics, they often served on curriculum committees at various levels of the institution. As interest in their work increased, so too did interest in diffusing analytics education across the curriculum, beyond individual courses or one-credit labs. This changed their impressions of the level of autonomy enjoyed by faculty members. Elizabeth lamented that the many different skill levels of students, and the inconsistent use of data analytics tools across the curriculum, made it difficult to build a consistent track of skills through a degree program. Elizabeth stated:

They [the students] are gonna get some [exposure to data analytics] in their data analytics class in spring. And then their senior class, they have nothing. Nothing. So they don’t practice. So by the time I get to them in the masters year, they have, you know, pressed
the reset button, and they are starting at Square 1 again. And I don’t want them to start at Square 1, I want them to start at, you know, Square 10.

Fiona chaired a number of advisory and curriculum committees and found it difficult to assess the skill set of faculty members and their interest in learning to teach data analytics. She reported that she could advocate for curriculum change, but could not move the needle without the dean calling for explicit change. She also felt that some faculty members were happy to speak warmly about the need for analytics education, but were unwilling to obtain the training necessary to facilitate the change. Fiona said:

Probably what stands in the way of [something] happening is, um, faculty who aren’t really up to speed but claim they are, but don’t want the training or don’t want it in their classes. But say they do. So… (laughs).

In both cases, the faculty hoping to lead change seemed to view the problem more in terms of inertia than intransigence, with a healthy appreciation for the fact that change takes time, and is not won immediately. Gwen spoke of using an incremental approach to take analytics education from a one-credit lab situation to becoming a part of the curriculum that recurs across a degree program:

Within the accounting department specifically, the challenge we face is trying to help our instructors understand how to incorporate all of this technology and changes throughout as opposed to it just being a standalone event. So I think that, that's the hard part. Um, they see me as the person like, “Oh, Gwen can go teach them Tableau and teach them Excel in her one course,” and we’re, we’re trying slowly to get everybody to adopt technology all the way through the curriculum, but it’s, it’s a slow process.
Just as instructors had to be wary of taking on too much work in their teaching when they first developed their own courses on data analytics, once they found themselves on curriculum committees, they realized they had to respect the same time commitments and personal views of their colleagues. The autonomy they enjoyed for their own work they also applied to their colleagues. By serving on curriculum committees, and with administrative support, some of the innovations they achieved in their own courses began to trickle into the curriculum. They expressed frustration with faculty who paid lip service for the need for change, but failed to act. But the participants counted this as a result of inertia typical of any organization and stressed the importance of incremental rather than wholesale change.

**Testing and Troubleshooting**

As previously discussed, introducing new tools and concepts requires an instructor to pretest and adapt them. Participants reported devoting considerable preparation time to train themselves on new tools, and also developing different strategies to address problems as they emerged in live classrooms. These might include troubleshooting the tools themselves or with ancillary tools, or becoming more agile in developing curriculum.

Derrick had perhaps the most telling experience, because he used only the teaching notes from a prewritten case in his first attempt at teaching Tableau. Because he did not seek training initially, he ran into a number of problems. He was also not familiar with the process of downloading a large dataset to a laptop, which can create delays in a live classroom. He said:

Yeah, it seems to put a strain on a lot of (laughs) uh, laptops, when you first put that dataset in there. I mean, to be honest, it was embarrassing for me, because... I should have worked through it myself, and should have been better prepared to answer the questions. But I assigned it, I, I knew that I had the solutions and I thought everything
would be fine. Uh, and then so many students were like, I, I can’t do this. And they were stressed out and, so, you know... I got stressed out when they were stressed.

Derrick expressed regret in not testing the dataset download ahead of time, but based his initial plan on his experience with teaching new material in the past. “I was just relying on the teaching notes, which I’ve done in courses, where if I have the teaching notes I feel pretty comfortable.” In the case of using new technology, though, he found that he had to pretest and run through the cases himself.

Other instructors talked about allowing for adequate preparation. They shared experiences in which they found their teaching plan required adaptation in a live classroom setting even when they felt prepared. Andrew reported that he felt he had gained adequate training on Tableau, but found he spent a lot of time helping students obtain access to the university’s cloud storage system where they would save the dataset. He had not anticipated that this would be an issue: “And so it, it’s that little stuff because they [the students] had never done it before. That took 20 minutes [of class time],” which was an unexpectedly large amount of time to get started. Bernard said he also had to adapt his instruction based on problems that emerged in the classroom. He said:

Oftentimes if one student makes a mistake, half the class is making the same mistake so...

So that has been sometimes a surprise in the classroom to, to see that kind of unfold, and then say, okay... So, I needed to, I needed to clarify this aspect of the activity more.

Both instructors viewed these mishaps not as a sign of an unsuccessful lesson but as an opportunity to refine it. Troubleshooting and adaption came with the territory of teaching something new.
The instructors provided varied estimates of how much time is adequate to feel prepared to teach a new tool or topic. These ranged from attending a multi-day training workshop (either virtual or in person) to spending as much as several weeks learning a programming language.

Elizabeth said, “I would say, you know, minimum a week, probably longer than that, just to get it acclimated and feel as though I’m able to successfully teach it.” Fiona reported that for a new tool like Tableau, she would devote 30 hours of training and practice to feel prepared. However much time an instructor devoted to training herself, the participants all emphasized the importance of maintaining a readiness to troubleshoot and adapt instruction based on issues that arise in class. Likewise, they stated the value of starting with modest expectations. Gwen said:

If it’s brand new, something’s probably gonna break in there, so…starting small…with small, smaller problems is great. And I was at a conference yesterday and I think I probably heard two or three faculty members providing the same recommendation and reflecting on, you know, making a change in their course.

For faculty who have taken a deep dive into a new tool or topic, it can be difficult to draw back and start with modest expectations for the class. A common strain among all the instructors was that the amount of time it took to train themselves exceeded their expectations, while the amount of material they could cover the first time teaching it had to be modified—or, in many cases, truncated. The participants agreed that failing to pretest tools can lead to major disruptions of classroom time. They found themselves troubleshooting minor issues they had not anticipated, for instance, using the university’s cloud storage for the data set. And they found that they often underestimated the time commitment required to train themselves and feel prepared to teach a new exercise.
Customization

A pervasive opinion among instructors who adopted the HUB of Analytics Education for teaching was that no OERs were ready-made for their classrooms right out of the box. They needed to customize the materials to some extent before they could teach to the objectives they viewed as important. These could be as simple as adjusting the time expected of students to complete an exercise, or as complex as introducing a new accounting platform or building a website so that the tools and course materials existed in a shared web space for students. The instructors appreciated not having to start from scratch, but they all found themselves putting their own creative spin on the materials they used.

The most common form of customization was downloading the dataset and prewritten cases from the HUB, and then either making changes to the dataset or rewriting the case to fit an exercise they wanted to teach. Bernard wrote a coursepack for his data analytics course rather than use a textbook. He found the cases for ACL and IDEA useful, and rewrote them to teach Python. He described his experience in trying to find cases for his course:

So you may need to come up with your own materials. Um, there are, there are some publicly available, accounting data analytics cases available, but it’s limited. There’s not, there’s not much out there. So be prepared to write your own.

Bernard was committed to teaching the programming language Python to his students, but found that there were few open source materials for teaching it to accountants. When he found the HUB materials for ACL and IDEA, he adapted those cases to teach similar operations within Python.

Fiona took a different tack, cutting the size of the data set to make it more manageable. She worried that the number of tools and supplementary open source materials in her course
were becoming unwieldy, so she worked with a publisher to build a website where all of the materials for her course could be organized. Christopher was pleased with teaching R using the dataset, but felt the next step was to start working with it within an enterprise system like NetSuite. He was in the process of doing this. Christopher stated:

It’s a matter of going and downloading the data that I need in order to do my analysis. If I’m a manager, I will use the same system. So, adding this extra component, it will make the, the whole experience more realistic.

Christopher had not yet completed the process of incorporating an enterprise system, but his desire to create a classroom experience that mirrored the professional world his students would encounter upon graduation compelled him to pursue this next step. Indeed, one of the purposes of customizing an OER is that the faculty member believes it can be rewritten to better reflect situations students will find in a professional environment.

Elizabeth and Gwen put their own spin on the data sets and cases. Like other participants, Elizabeth was driven by the desire to simulate an accountant’s professional experience with a large data set. She defined her own cases and changed the dataset in a manner she described as “reverse engineering.” The data set came to her clean, but, she said:

I like to throw wrinkles in things… I sort of reverse engineer it so it doesn’t tie out and it doesn’t agree so that my students have something to find. And when they don’t find something with me, they’re, they’re very suspicious.

She viewed this experience as more authentic than working with clean data sets. It forced her students to adopt a more critical and diagnostic approach to working with data.
Similarly, Gwen rewrote cases every semester to provide students with the opportunity to build a variety of visualizations from the data set. She also found herself taking cases designed for one subdiscipline in accounting and applying them to another. She advised:

(Do) not be limited by the title of the assignment… I use that management accounting set, but I don’t use it in a management accounting class. I use it in accounting systems. So don’t be limited by that.

This is an open and creative approach to adapting open source materials, a habit of mind that many faculty members already have with textbooks and seminal readings, applied to digital teaching tools in an emerging discipline. They manipulated the data sets so that they more accurately reflected what students might find in a professional setting, and rewrote cases to create more authentic learning experiences. In many cases, they took OER designed to teach a different tool or subdiscipline of accounting, and adapted it for the tool or subdiscipline they were tasked with teaching. The participants did this to avoid having to create materials from scratch, which saved them time and harnessed the creativity of educators who had tackled similar instructional tasks.

**Influencing Peers**

One of the challenges of adopting new technology for teaching and learning is then to diffuse a successful practice across an organization. Because the participants were the first in their departments to teach data analytics for accountants, they had the added responsibility of communicating their experience to colleagues and advocating for wider adoption. These instructors developed a number of strategies to accomplish this task. These included informal communications via email or in department meetings, intentional collaboration across
departments, serving as a training resource, advocating for data analytics electives to become required courses, and serving on curriculum and hiring committees.

Whenever instructors found themselves developing into a resource for other faculty members, this role compelled them to transform themselves into an advocate and professional development trainer. Bernard reported spending time informally communicating, via email and at professional events, with colleagues both within and outside his institution who were interested in teaching data analytics. He also found himself in the role of facilitating professional development events for colleagues within his own department. Bernard stated:

I developed kind of a little bit as a resource for some of the other faculty who are doing some of these integrations. And so, so I think that’s been beneficial… You know, for example, uh, over the summer we're doing a Tableau workshop here, you know, with all the faculty and so, um, so again, I think, I think I’ve been able to help kind of drive that process a little bit.

Bernard does not claim complete ownership of initiatives to teach data analytics for accountants at his college, but he has assumed a leadership role. He wrote a grant that obtained funding to run the workshop, and he invited a representative of Tableau to attend and support it.

Christopher took a similar tack, and also demonstrated interest in becoming a thought leader for the discipline in the wider academic community. He shared materials with colleagues and sought feedback, and he also spent significant time at conferences presenting his experiences teaching data analytics. He considered it important to share the materials he built for the HUB cases and for his classes. He also served on his college’s curriculum committee, where he used his materials to advocate for more data analytics instruction. He said:
For the last two years, I’ve been part of the strategy committee. And uh, we are redesigning our curriculum. And all of this material that I’ve developed will be implemented as part of the new curriculum.

By presenting at industry conferences and serving on the curriculum committee, he hoped to influence the way faculty teach data analytics. Andrew and Fiona took similar routes to influence colleagues at their institution. A trend emerged as early-adopting instructors would develop their own course on data analytics; the course would then be piloted as a one-credit elective taught by other instructors; and eventually, if successful, the course would become required within the degree program.

Elizabeth was less bullish on the prospect of influencing peers, as she talked about how she attempted to share her findings with colleagues despite their doubts. Rather than pushing her ideas through the department, she recruited a new faculty member who shared her interest in data analytics to collaborate on teaching with a scaffolded approach. Elizabeth taught students concepts in data analytics early in the program, while the new colleague would build on what Elizabeth had taught in courses later in the program. Asked whether she thought she could influence peers, she said:

Um, I don’t know, I don’t know if they're gonna be influenced (laughs)… Well, I do have another colleague of mine who is in the process of changing her cost accounting to more of a data analytics course. She follows me in the junior year so, um, so we are doing, um—and her and I are very collaborative—so we will, there’ll be a little bit of a relay with us, where I will hand over to her sort of where I left off, and she will pick up from there.
Here Elizabeth has judged that her peers may be less receptive to her ideas on teaching data analytics, but she has identified a colleague whom she has found to be sympathetic. By collaborating with her, Elizabeth pursued another avenue to build upon the work she accomplished in her own course. If curriculum committees were slow to implement change, participants also used informal communication channels, or sponsored professional development opportunities using their own networks. And some participants sought to establish themselves as thought leaders in the discipline by presenting their teaching experiences at professional conferences. What is interesting is that even when participants felt supported by administrative leadership, they sought other means beyond formal governance structures to influence teaching practice.

**Summary**

In adopting new technologies and methods for teaching data analytics, instructors navigated a path from discovery to implementation that required them to stretch themselves to open up new opportunities for teaching and learning. They harnessed the autonomy they enjoyed as instructors in academic settings to test new ideas in their classrooms, and they also assumed roles as advocates, professional development trainers, and departmental committee members to help their findings become diffuse across their colleges. Some expressed a certain wariness of overextending themselves. But they budgeted time to train themselves on tools and programming languages, and they also developed new strategies and habits of mind to overcome the facts that they were not yet experts in the developing field of data analytics and that technology does not always behave as expected the first time through. Participants reported customizing the materials they adopted to better reflect the professional environment for which they were teaching their students. They did this by manipulating the data
sets so students would have to adopt a diagnostic approach. Participants also rewrote cases so that they had greater applicability to the tool or subdiscipline of accounting they were teaching. This saved them time in preparation and harnessed the creativity of fellow educators who had already tackled a similar teaching task.

Finally, participants sought to influence their peers to teach data analytics by serving on curriculum committees and sponsoring professional development opportunities for their colleagues. If they bumped up against inertia or red tape, they sought out colleagues to collaborate with, and used informal communication channels to share their work.

No one instructor’s path from discovery to implementation is preferable or recommended, as the situations are highly contextualized. Even so, a keen understanding of one’s own institutional environment and the levers that exist for change served as an asset for the instructors. They also developed a mindset of humility as they recognized that self-training would take longer than expected, and that their expectations about the amount of material they could cover in the first iteration of their courses would have to be tempered. The strategies they adopted to influence their peers were based on the relationships they had with colleagues and the leadership roles that were available to them. Most adopted a flexible and incremental approach to change, which respected the autonomy and prerogative their colleagues enjoyed in their own teaching.

**Conclusion**

The purpose of this study was to explore the experiences of professors of accounting who sought to adopt tools and programming languages to teach data analytics within their respective colleges of business. Analysis of the transcripts from an in-depth interview and a follow-up interview revealed shared themes—as well as the uniqueness—of each of the instructors’ experiences as they struck out on their own to teach concepts in an emerging field in their
profession. This chapter began by presenting how the instructors made sense of the rapid pace of change in their profession, and what this change meant for them as they sought to mirror the professional environment in their classrooms. It then explored how the pressure to change their methods of instruction influenced their role as a teaching professional. Lastly, it charted the path they followed as they moved from discovery of an OER to implementation in teaching practice and, ultimately, diffusion across their college and institution.

A study of professional teaching practices must begin with a discussion of the professional environment in which these instructors were teaching. Changes in the accounting profession were the primary driver behind these instructors’ recognition that their teaching practices needed to change. Foremost among these changes was the role of automation in the accounting profession: the reality that entry-level work in the accounting profession, such as data and journal entries, was being automated. There was now a premium placed on developing analytical and critical thinking skills among accounting professionals, so that they could interpret data effectively and present actionable information at the managerial level. The steps instructors took to introduce concepts in data analytics kept this learning objective in mind, even though they recognized that to arrive at this objective, they would still need to teach students how to make a journal entry and all of the other fundamentals built into the requirements of a degree program and the CPA exam. The instructors also tried to increase their engagement with accounting firms to understand the proliferation of tools and programming languages used in the field. They did this to make informed decisions about the tools they would introduce in their own courses. They also developed strategies to make the processes of evaluating these tools more efficient. These efforts created demands on their prep time that typically exceeded the review of a new textbook or a piece of published research.
As changes in the accounting profession put pressure on the instructors to change their teaching practices, the participants also found their role as instructors changing. They reported developing preferences for teaching strategies that moved beyond lecture to more active and flipped learning environments, in which students worked in lab settings and on teams to analyze data and solve real-world accounting problems. Instructors sought support from colleagues outside of the accounting department, in computer science departments and IT departments, to discover new methods and tool availability. They found themselves in live classroom situations where they did not have ready questions, but instead had to establish workshop scenarios in which they learned alongside students. The participants found this to be unnerving, and also exhilarating and stimulating. As they sought resources outside of their usual communication channels, they found themselves stretching themselves, embarking on journeys of intellectual play and self-discovery. They developed technical skill sets beyond those typically expected of an accounting professional, ones that were better attuned to the changes occurring within the profession at large.

Lastly, as the participants worked to implement data analytics concepts in their courses, they dealt with a number of common factors. While they enjoyed autonomy to test new ideas in their classes, they also had to navigate the institutional environment they found themselves in. This could both facilitate and inhibit the diffusion of their successes throughout their colleges of business. They presented at conferences, wrote grants for and presented at training workshops, served on curriculum committees, and recruited sympathetic colleagues to diffuse data analytics concepts throughout the accounting curriculum. Sometimes, they bumped up against colleagues who publicly supported these efforts but were hesitant to change their own teaching practices. The participants were somewhat sympathetic to this, because they could recall the number of
hours they spent to become proficient in the tools they taught and to customize the materials they adopted for their own specific learning objectives. Moreover, they recognized the tenuous situation they had thrown themselves into, having to learn alongside students and troubleshoot technical issues in live classrooms, something not required in a traditional lecture format. Sacrificing the authoritative voice is not something that comes easy. But all of the participants viewed their work as a pedagogical imperative. If the profession shifted in its priorities, then so, too, would their instruction.
Chapter 5: Discussion and Implications for Practice

The purpose of this study was to examine an initiative at a large private research university to provide an online, open source data analytics curriculum for accounting courses at the university level. It explored the experiences and motivations of instructors, acting as early adopters of the open educational resource, to teach data analytics skills and tools to university students. Rogers’ diffusion of innovation theory was adopted as the theoretical framework, because its structure provided relevant guideposts along a professional’s path from evaluating a piece of technology to mature use. The framework also gave significance to the social negotiation that occurs as a piece of technology moves from isolated to widespread adoption within an organization. This study employed interpretive phenomenological analysis (IPA), a qualitative research methodology concerned with how individuals make sense of significant events in their personal and professional lives. In this case, the phenomenon in question was the process undertaken by university instructors to adopt an OER to teach data analytics to university students.

Analysis of semi-structured interviews yielded three superordinate themes and 11 subordinate themes: 1) Teaching for a Changing Profession (1.1 Constraints of the accounting curriculum; 1.2 The role of automation; 1.3 Listening to firms; 1.4 Evaluating tools and programming languages); 2. Charting a New Path as an Instructor (2.1 Changing the approach to teaching; 2.2 Learning alongside students; 2.3 Seeking resources and training); and 3) Discovery to Implementation (3.1 Institutional environment; 3.2 Testing and troubleshooting; 3.3 Customization; and 3.4 Influencing peers).

This chapter starts with a treatment of the study’s findings within the context of the theoretical framework and current literature on the topic. Subsequent sections highlight the
finding’s implications for practice in the domains of higher, continuing and professional education, as well as suggestions for future research.

**Findings**

**Teaching for a Changing Profession**

The participants in this study, who worked in accounting departments at universities in the US and Canada, adopted the dataset and teaching materials from the HUB of Analytics Education in their accounting courses. The materials and dataset were developed at Northeastern University for this general purpose. The instructors adopted the materials in their own unique way, but some common subordinate themes emerged as they adapted their instruction. The following section discusses the subordinate themes as they relate to the theoretical framework and literature review.

A common difficulty experienced by the participants in this study was the sense that the field they were teaching for was changing, but the nature of that change was unclear. This compelled the instructors to conduct fact finding missions to learn more about the change, which would in turn shape the structure and content of their classrooms. All of the instructors could say with confidence that entry level tasks were being automated, and that the professional accountant of the future would have to work comfortably with data and technology, but exactly how was subject to interpretation. A major headwind in the process of developing an accountant fluent in these skillsets was the rigid structure of the accounting degree path, as was currently in place. Course content was already tightly packed into the curriculum, leaving the instructors struggling to find time and space to teach for skills in data and technology. Most often, content of this nature was taught in one-credit labs or in courses on accounting information systems. But there was a sense that this provided one-off exposure, rather than consistent development across the
curriculum. Because this problem is uniquely situated in the accounting profession, analogues in the literature are limited. But it became apparent to the instructors that the solution to the problem quickly evolved from one of individual technology adoption to institutional adoption. This finding aligns with the notion that questions of technology adoption should be viewed from the institutional perspective of policy and strategy (Redmond, 2003; Graham, Woodfield and Harrison, 2013; Porter and Graham, 2016). It was not enough for faculty to adopt and teach data analytics tools of the future workplace in their own courses; rather, they would have to be strategically placed across the accounting curriculum.

Another issue that compounded the problem of curriculum constraints was the increasing role of automation for entry level tasks in the profession of accounting. These entry level tasks could include data entry and journal entries, which meant that the entry level work of the future demanded more critical-analytical skills. Newly hired accountants would be serving less as gatekeepers of data and more like analysts, interpreters and consultants. The challenge for instructors was to assist students in developing these higher order skills, while teaching the fundamentals of accounting, which were needed to arrive at the higher order skills. In other words, faculty had to teach accounting skills that were in the process of being automated in order to teach higher order skills for which the current curriculum allowed only marginal space or time. In this context, the value of OER for teaching data analytics comes into play, dovetailing with research on how OER can provide for flexibility in use of class time, enhanced critical analysis skills, and increased faculty enthusiasm for new forms of teaching (Griffiths et al. 2015).

As instructors became increasingly aware of changes to the accounting profession, they started to gather additional information on the nature of the change. Information seeking is one
of the earlier stages in diffusion of innovations theory, as adopters learn about and begin to assess an innovation. Because the training and eventual employment of accountants adheres to industry standards, there are recurring and robust communication channels between academia and industry. Nearly all of the instructors in this study had worked at an accounting firm at one point in their career. Their professional networks extended well beyond academia into the professional world. And employers made regular visits on campus to train faculty and students on next practices and recruit talent. In diffusion of innovations theory, a few distinctions are made about the communication channels used to learn about and assess an innovation. In this case, the communication channels were both localite (informal, peer-to-peer) and highly cosmopolite (consumed via mass media or expert resources). Instructors would consult with peers in separate colleges on campus, which represented a much more localite channel. But they would also attend and present at conferences, or contact former colleagues at accounting firms, in order to learn more about how technology was used in the field, both of which were far more cosmopolite. Turning to another institution or a Big Four accounting firm for teaching resources represents intensively cosmopolite information seeking.

Another angle to consider in information seeking among faculty is the level of technological expertise they bring with them to the task of adoption. Some researchers have expressed concerns that low levels of technological expertise may lead to faculty adopting technology in ways that are ineffective (Reid 2014). In terms of evaluating tools, instructors in this study related that they felt they improved with time at this practice. Most of them came to technology adoption with an interest in learning about new tools and practices in the field, and an above-average level of technological expertise. This made them well-equipped for the task and allowed them to build on prior knowledge. While it is difficult to assess how their backgrounds
shaped their information seeking and tool evaluation preferences, the findings align with research that suggests that greater technological expertise leads to a greater preference for self-directed information sources, which can be predictive of technology adoption (Lane and Lyle 2010). All of the instructors sought training from tech vendors and industry associations as they evaluated tools, both of which were self-directed initiatives.

After emerging from the information seeking stage of adoption, instructors came upon the question of whether to teach a software tool or a programming language. The participant with the highest level of expertise in data science expressed a preference for teaching programming languages. Other instructors decided to teach only a software tool. At the same time, some opted to teach both a piece of software and a programming language. Their rationales for teaching in all of these cases are supported by research demonstrating that the complexity of tools can impact decisions to adopt (Reid 2014). Faculty with lower levels of technological expertise lean toward software programs, while those with greater expertise may opt to take the leap toward learning and teaching a programming language. (More research needs to be done on the extent to which accountants are using programming languages versus software in the working world, as learning a programming language is a much heavier cognitive lift.)

**Charting a New Path as an Instructor**

The first set of findings in this study revealed an acknowledgment among instructors that the field they were teaching for was changing. The second set of findings dealt with how faculty adapted their instruction to meet this change. Professional roles were changing, tasks were in the process of being automated, new skillsets were in higher demand: what did this mean for the instructor’s role? For the instructors in this study, it meant that they would have to change their approach to teaching by adopting new pedagogical strategies, reorient their relationship to
students in the classroom, and seek resources and training to learn the new skillsets of the accounting profession.

Because data analytics is dependent upon statistical and computing power, most instructors found themselves teaching the topic in a lab setting with computers. This called upon a different teaching skillset than those of the lecture hall. They reported moving in the direction of pedagogical models that tended toward active and flipped learning configurations, with more team-based approaches and peer-to-peer feedback. This finding aligned with the research of Griffiths et al. (2015), which argued that the adoption of technology through OER supported different teaching and classroom organization styles, and spurred enthusiasm for new forms of teaching. Similarly, because the change in their approach was driven by changes in the professional world, they sought to build more experiential exercises embedded in these contexts, collaborating with faculty and students in other departments to solve problems a student would likely encounter in their first job. One instructor assigned students to write reflection papers as they learned concepts in data analytics, which helped students to chart their own meaning making process. This, in turn, assisted the instructor in understanding the student’s learning journey.

While instructors changed their approach to teaching, they found themselves in different roles, both in relation to themselves and to their students. Along with this change came a sense of disorientation, which warrants attention, as it is common to any context in which a person must change behaviors to achieve results. One instructor spoke of an epiphany he had while taking guitar lessons. After struggling as a novice, he reviewed his lecture notes for situations in which his students came to him as novices. He realized he had been asking too much in the early stages of instruction. Other instructors shared experiences of the challenge of gauging the level of
difficulty of content, even after learning it very recently before teaching it. All of them reported having to temper their expectations from the outset.

An added challenge came with the ambiguity and uncertainty of teaching with new tools in new pedagogical models. Instructors no longer considered themselves complete experts in the content they were teaching. Instead, they admitted to often learning the material just slightly ahead of students, which narrowed the power relationship between faculty and student, expert and novice. This could be an unnerving shift in identity for faculty, and most acknowledged being unsettled by the change, at least initially. They also reported a sense of satisfaction in the experience of stretching themselves as instructors, learning alongside students in tackling problems. One instructor described it as a journey of self-discovery. In this new context, instructors reported a sense of becoming more agile, addressing problems and questions on the fly. They built learning environments with a greater dependency on peer-to-peer support, harnessing the strengths of individual students. When the class as a whole struggled with a problem, they worked in teams—and shared work across teams—to solve it. Instructors viewed themselves more as coaches and facilitators of this process, rather than didactic channels of knowledge. The sense of co-creation was much stronger compared to earlier iterations of their courses.

These findings relate strongly to research on faculty adopting technology for teaching and learning, and the adaptation process that happens not just with the introduction of new materials but with the teacher and learner roles themselves. Tanner, Noser and Totaro (2009) argued that students found the introduction of technology into learning environments provided added value to the learning experience. Faculty are wisely skeptical of technology without evidence to support it, but could keep in mind the student perspective, in which exposure can have
significance in addition to performance results. Instructor experiences in this study also aligned with research on the student experience in tech-mediated settings where learning was more group-oriented or self-directed. Students often struggle self-regulating in group projects, or managing the autonomy implicit in being assigned a problem to solve on their own (Kim et al., 2014; Roby et al., 2013). Bailey et al. (2015) noted that both instructors and students must negotiate changed assumptions about their roles in the learning process.

An interesting irony of this co-created learning environment is the concern that some faculty report about the loss of a humanistic element in tech-mediated settings (Marzilli, 2014). This concern is directed primarily at online learning settings, while this study focused on face-to-face settings. Even so, the difficulty of the material being taught required a more hands-on approach, eliciting a relationship between teacher and learner in which greater collaboration occurred, not less. The greater the complexity of the technology involved, the more instructors and learners leaned on one another to explore its capabilities. One instructor noted that the most authentic assignments pose a question for which nobody in the room has a ready answer. Consequently, the class must struggle together to solve it. She viewed this to be a profoundly accurate simulation of the type of problem solving that occurs in a professional setting.

One final consideration for this section relates to the theoretical framework, or the type of information gathering instructors conducted when determining how to teach data analytics to their students. The first finding related to how instructors conducted information gathering on the professional field of accounting, or rather, the types of tools available and whether or how they were used. The information seeking had cosmopolitan tendencies, as instructors reached out to firms, industry groups and vendors of tools. But when it came to the question of how to teach data analytics concepts, they often turned to other departments within their home institution. For
instance, some instructors turned to the IT department, or to colleagues teaching statistics or data science. In this way, the information seeking was more localite, and required a higher level of trust. The information seeking was also spurred by a desire to collaborate with faculty in other departments in cross-disciplinary assignments. Students might tackle a business problem in teams, with students from data science bringing their expertise and students from accounting theirs as well.

**Discovery to Implementation**

The last finding of this study dealt with the process of moving from initial adoption to diffuse practice. Instructors, once deciding upon a skillset and a pedagogical approach, had to negotiate additional obstacles. The first of these revolved around customizing the tools and teaching materials they adopted, as well as testing them before class and troubleshooting while in class. Instructors also cultivated an awareness of the institutional environment in which they operated. They enjoyed a fair level of autonomy to teach as they saw fit. But as their work gained a higher profile, they found themselves serving on curriculum committees, in which they had to influence the teaching practices of their colleagues. Diffusion of teaching practices would have to proceed through normal channels of faculty review. Infusing data analytics skills and concepts across the accounting curriculum depended on both administrative and faculty support, which could conflict with issues previously mentioned (the tight accounting curriculum) as well as faculty workloads and resistance.

Issues pertaining to customizability and testing and troubleshooting are well documented in the literature and are equally well supported in this study. Faculty wish for tools and OERs that are adaptable to their specific context, and are supported by the tool vendor and the infrastructure of their institution (Bacow, 2012; Murphy, 2013; Wang et al., 2013). All
instructors in this study downloaded the data set from the HUB of Analytics Education, and most made changes to the data to fit the context of their classrooms. They also rewrote teaching cases for real-world applications they found more suitable. This highlights one of the strengths of OERs. Instructors can take what they need, and then adapt or discard what they do not. But some research cited a hesitance among faculty to use materials they did not design themselves (Bacow et al., 2012). This finding runs counter to the experience of instructors in this study, who viewed OERs as a necessary component for teaching data analytics. (The participants in this study overwhelmingly sided with the notion that there was a dearth rather than a surplus of OERs for teaching data analytics to accountants.) The task of learning a new discipline and building teaching materials for their courses was simply too large to build from scratch. They had to lean on resources developed by vendors, firms, peers and other institutions, and they developed a greater degree of comfort in assessing and curating materials for this purpose.

So even though faculty recognized the necessity of adopting materials they did not create, the desire to customize the teaching and learning experience did not disappear, but rather threw a wrinkle into the normal adoption curve. After the tool assessment and selection phases, there remained a desire to adapt the tools for specific contexts. This notion is supported by research on learning management system adoption, in which faculty rate the reconfigurability of an LMS as a crucial factor to its use (Wang et al., 2013). This opens up a conundrum about which faculty often remain unaware. And that is that the greater customizability and reconfigurability a tool has, the more decisions around design and function are laid in the hands of the user. This often leads to tools with menus littered with options that faculty are often unconcerned with. Complex menus and interfaces, in turn, lead to user experiences with steeper learning curves, which can appear unwieldy and difficult to negotiate. Furthermore, they generally require more computing
power to run. The reality is that most professionals use a small handful of tools offering high levels of reconfigurability, but would prefer tools for ancillary tasks to be simple to learn and apply. Likely for this reason, most participants in this study decided to select one or two data analytics tools or languages, and then to focus on them intently. Learning a few tools in depth was more important than gaining knowledge in breadth.

Once participants began teaching with data analytics tools, they found themselves in situations where they had to influence peers to promote diffusion of the same practice across the college. This final step of technology adoption relates to the job structures and social networks within individual colleges, as well as the rewards and incentives for innovation in teaching practice. The autonomy enjoyed by faculty at research institutions acted as a double-edged sword. It provided faculty the leeway to change their teaching practice at the individual level, but could inhibit technology adoption at the organizational level, offering faculty the prerogative to opt out.

The literature is rife with commentary on how incentive structures and leadership can impact the adoption of innovative teaching practices, pushing toward higher rates of diffusion. Participants in this study arrived at a general consensus supported by both the academic research and the education technology community, which is that time allowances for developing teaching practices are more effective than financial incentives (Bacow et al., 2012; Robey et al., 2013). As participants in this study established themselves as thought leaders on teaching practice within their colleges, they found themselves serving on curriculum committees to influence the teaching practice of their peers. Elevating instructors who are pushing the boundaries of teaching practice to these positions is both intuitive and supported by research. Championing pioneers as
exemplars and placing them in positions of greater administrative power has been found to have a positive and motivating effect on peers (Bacow et al. 2012; Reid 2014).

Another notion that participants touched upon in this study is their perception of leadership as being supportive of their teaching practices. They were generally positive in their assessments of leadership at their institutions, noting that they felt empowered by the language they heard from leadership to pursue new practices in teaching and learning. But upon arrival in curriculum committees, they found few levers for promoting diffusion of practice among their peers. This generates a gap between paying lip service to change versus actual implementation, which many participants noted within their organizations. It also aligns with an interesting irony that occurs in many organizations, in that exemplary work is often rewarded with additional work in the form of administrative responsibilities. Another finding that aligns with this reality is that most institutions do not include the adoption of emerging technologies as a factor in tenure review and faculty promotion (Hoyt and Oviatt, 2014). Other researchers have suggested that tenure review and promotion should directly confront what technology adoption means in this context (Reid, 2014; Bacow et al., 2012).

Most participants in this study seemed at a loss when it came to promoting diffusion of data analytics tools in the accounting curriculum. They could collaborate with peers on smaller projects, or in passing on materials from one level of the curriculum to the next. But diffusion across the degree program seemed too complex, or at least too fraught, to tackle. Some of the research on this problem has suggested aligning faculty research interests with technology adoption for teaching and learning (Roby et al. 2013; Sahin and Thompson, 2007). This lends greater weight to the work, since research generally captures greater faculty interest and attracts more attention from peers in terms of prestige. The participants in this study were not actively
engaged in research on the effects of their teaching practices, but the questions they raised about the process demonstrated an interest and a passion for shedding more light on what was occurring in their classrooms.

This discussion traced the motivations of faculty adopting an OER to teach data analytics to students of accounting. It employed the key factors of Diffusion of Innovations Theory to plot points along this path, and related those points to existing literature on OERs and technology adoption in higher education. The findings of this study make no claims on the relative performance of the participants in teaching data analytics, but it does identify the participants as early adopters in this task and follows their meaning-making process. The depth of the analysis should provide sufficient weight for future inquiries into technology adoption in a higher education setting, using Diffusion of Innovations Theory and interpretive phenomenological analysis, and help to better illuminate settings in which professionals attempt to adopt technology to respond to changes in their field.

Conclusion

The research question for this study was: what motivates instructors to adopt an open-source digital teaching tool? Embedded in this study was a follow-up question related to the theoretical framework, Diffusion of Innovations Theory: how do instructors view their decision to adopt as having an influence on the teaching practices of their peers? The answer to the first question arrives primarily in the first finding, which demonstrated that professors of accounting had become acutely aware of changes in the field for which they were teaching. These changes became a primary motivator for changes in teaching practice. This sets in motion a domino effect of technology adoption in which professionals respond to change by seeking information on innovations, assessing and selecting options, implementing, and influencing peers to follow suit.
The motivation is neither wholly altruistic nor self-interested, but rather necessitated by observing a change in conditions. This may seem self-evident, but acting as early adopters, the participants in this study were uniquely positioned—via their academic roles and information networks—to identify a need for change and to set a course of action.

The findings of this study relate to the growing field of literature on education technology, which has grown from research comparing learning in online to face-to-face environments, to include research on OERs, MOOCs, e-credentials, and barriers to adoption. The learning settings in this study were still high-touch and face-to-face, but also highly tech-mediated, occurring in lab settings with computers and software programs. A major outcome of this situation was a learning environment that dissolved traditional teacher-learner roles, and elicited a co-created learning environment with more input from learners and less expertise on the part of the instructor. All of the instructors discussed how they came to terms with having to teach a subject for which they could not adopt the same authoritative voice as in the past. Learners, too, had to develop a greater sense of agency in knowledge creation. It could be disorienting, but also enlightening, as the challenge stretched both instructors and learners.

The final finding showed that participants, through the adoption of technology and refinement of practice, developed certain skill sets in self-training and influence. They learned to budget their time in assessing tools, became more agile in the classroom to troubleshoot problems, and developed a deeper understanding of institutional norms and procedures. It became clear that participants still struggled with how to influence peers in an environment where faculty enjoyed a high level of autonomy. But they used their positions on curriculum and strategy committees to advocate for data analytics education across the curriculum, and served as planners of professional development opportunities to support their peers.
What is unique to these findings is that they provide greater depth to the experiences of early adopters in a situated context that many people working at higher education institutions find themselves in: responding to a rapid pace of change in the professional world, instructors must gather information from myriad sources to determine demand for an emerging set of skills. And then find a way to teach for them. This is a highly interpretive activity. Yet the experiences of the participants in this study provide guideposts for the process, as well as a template for how the efforts of early adopters can be better supported and then transferred to more diffuse practice. The next section describes the implications of these findings for practice and recommendations for future research.

**Recommendations for Practice**

After working for six years in academic technology at a large private research university, the researcher became intimately involved with the process of supporting course design and technology adoption for teaching and learning. This study provided the opportunity to engage in greater depth with faculty members similar to those he supported on a daily basis, with the aim of understanding what motivated them to change their teaching practices. After only a few years in the field of education technology, the initial questions most commonly asked of technology—what works and what does not?—gradually yielded to a more pressing dichotomy: who adopted, and who did not? And why? The researcher found himself training faculty on a large and well-funded suite of technology tools, most of them supported by evidence-based applications to teaching and learning, but observed only marginal rates of adoption. This created an imperative for moving away from initial tool training to disseminating the lessons and next practices of early adopters, the topic of which made up the bulk of the conversations with the participants in this study. This section highlights recommendations for making their experiences better known.
to the academic community as a whole, and has implications for software designers, educational technology professionals, administrators, faculty and students.

**Formalize Market Research and Outcomes Assessment**

If the motivations of the participants in this study could be paraphrased, it would sound something like, “I know for sure that change is afoot, but I don’t quite know what the change looks like.” All the participants were convinced that the students they were teaching at present would need an expanded skill set in using data and technology to be competitive in the labor marketplace of the future. The irony in this situation should not be lost on the reader, because colleges of accounting have some of the highest job placement statistics of any college found on university campuses. The jobs are white collar, well paid, and the path from degree to entry level job has historically been well defined and fairly certain. But even this profession has succumbed to the disruption of technology and automation.

Organizations that typically hire accounting majors are currently seeking highly-skilled professionals who are comfortable working with large data sets and the technology used to analyze them. A student who develops these skills in a degree program has an advantage over a student who does not. This puts pressure on institutions to understand what skills firms are hiring for, and then develop curriculum to teach them. Individual colleges need to engage in market research on hiring trends among the firms where their students are landing, or where they aspire to land, and use this information to adapt curriculum and persuade faculty buy in. Individual colleges must also seek feedback from alumni to find out what segments of the curriculum students are applying to their work, and what they wished they had learned in the classroom prior to the first job, and the second. Institutions could also seek feedback from alumni and firms on the types of skills needed in graduate and certificate programs. That is, if you returned to your
home institution to up-skill, what would you need to up-skill on and what would be the desired outcome?

**Identify Early Adopters and Elevate Them**

Most evaluations of teaching at universities are the result of student feedback surveys at the end of a semester. These can be positively and negatively affected by instructors’ attempts to innovate in their teaching practices. But performance evaluations of faculty should include some form of self-reporting on innovative practices they adopted and their rationales for doing so, with rewards in the form of promotion for instructors who are able to match innovative practices to labor market demands and evidence-based education research. Those who are able to make this case effectively should have their efforts highlighted in teaching showcases and workshops for innovative practice. Hoyt and Oviatt (2014) found that very few institutions considered faculty use of technology for teaching in tenure and promotion review. This could be changed rather easily. Similarly, efforts to spur adoption could be aided by elevating those who have succeeded at it, and using their work as exemplars for others. Most often, technology investments come with minimal instruction on what use looks like in effective practice. Ertmer (1999) argued that faculty must be given examples of the type of work they are expected to produce, and then be given opportunities to evaluate and implement.

**Tie Academic Innovation to Education Research**

Many universities have teaching and learning centers that provide fellowships to faculty members to conduct research on their teaching practice. The faculty member will identify a specific teaching practice—for instance, flipped classroom design—conduct a mini literature review, design instruction to incorporate the practice, and then perform research to develop findings on the process. These fellowships go to willing participants across the university. But
individual colleges could harness similar programs targeted to their own needs. In this context, and in collaboration with a teaching and learning center on campus, instructors could develop curriculum to test outcomes of students learning a data visualization software program versus a coding language, or a mix of the two. This is just one example of how individual colleges could develop their faculty into education researchers and promote innovation across the curriculum. It would require guidance from leadership and support from education technology and education research groups, but it would likely find willing participants among the early adopters within faculty ranks. And the research topics could be guided by market research on in-demand skill sets and student outcomes in the workforce.

**Bring Everyone into the Mix**

A major complaint against the rising cost of higher education is administrative bloat. Even so, a cadre of departmental administrative assistants and graduate teaching assistants will remain to assist teaching and learning, as long as there are instructors who teach. Indeed, people who fill these roles bring significant value to the colleges they serve. But most of the tasks assigned to these roles involve maintaining schedules or grading papers and assignments. It would be well within their realm of expertise, and even empowering, to provide them training on and some responsibility for the crucial technology tools used for teaching and learning. Administrative assistants could copy courses and assignments within the learning management system from semester to semester, and graduate assistants could maintain repositories of successful lesson plans and OERs. They could also pull reports from the learning management system comparing performance across different sections, or comparing different pedagogical approaches to teaching the same material. Many administrative support staff pursue higher learning through masters-level programs in education, yet their input is rarely sought. It
represents a missed opportunity for innovation and technology adoption that their expertise goes unused.

**Recommendations for Future Research**

It is worth restating that this study is embedded in a higher education context in which greater pressure exists to create more relevant and experiential learning experiences with measurable ROI post-graduation. Old-school pedagogues will lament the intrusion of the logic of capitalism into education, but there is no way of avoiding the fact that education creates value—both financially and intellectually. And this value will continue to be assessed as long as people seek to be educated. Likewise, no matter the discipline, good pedagogy demands authentic learning experiences with applications to real-world problems. The best educators are constantly addressing the question of “why learn this” to establish a hook for an engaging lesson plan. Future research on education technology adoption and OERs will tackle this question as well.

Institutions of higher education must engage in better market research on labor force demand and then translate these findings into curriculum changes that address demand. Most institutions have relationships with employers that hire their graduates, and this type of research could support deeper relationships and demonstrate to partners that educators are listening to their challenges. Future education research should focus on how institutions collect this information, analyze it, and move it through academic information channels to create curricular changes. How do institutions discover actionable insights and avoid responding to flashy trends?

Future research on OERs should also address the decision-making process of college deans and department heads on how to develop future classroom content. One of the advantages of OERs is that they teach a new topic, or they teach it in a new way that instructors find
interesting or valuable. When OERs are unable to fill gaps that instructors have identified, higher education institutions have a number of options to move forward. They can develop learning materials in house, contract with an instructional design vendor or technology company, or even employ a large program manager to assume responsibilities for content development, recruitment, enrollment, marketing, and customer support. Higher education institutions have been negotiating these decisions for two decades, but very little research has been conducted on how administrators arrived at their decisions and what the outcomes were.

Similarly, an emerging trend in higher education is to build certificate and badging programs that develop and highlight in-demand skill sets with shorter paths to completion. Future education research should track the outcomes of these initiatives as they address the demands of professionals. Administrators should target these initiatives strategically, as the marketplace is already flooded with certificates and badges of uncertain value. Future research should seek to delineate when and how a certificate or badge has created value for stakeholders versus more market confusion.

Lastly, this study focused on the instructor side of technology adoption, and the literature review demonstrated that more focus has been given to student rather than faculty perceptions of technology in teaching and learning. More research is still needed on how faculty perceive their role in implementing institutional investments in technology for teaching and learning. This includes what they view as an appropriate role for themselves in the technology procurement and assessment process, and what constitutes an adequate and effective level of adoption across faculty ranks. Existing research has asked faculty what types of supports they find helpful for adoption, but future research would ask them how they envision technology aiding them in their roles as teachers, and how they would like to be evaluated as users of technology. The goal
would be to discover what level of agency faculty would prefer in the adoption process, whereas previous research has addressed faculty in a reactive role. IDT and IPA both serve as useful paradigms to arrive at a deeper understanding of the faculty experience in teaching with technology.
References


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Appendix A: Diffusion of Innovations S-curve

Appendix B: Decision Model

Appendix C: Notification of IRB Action

NOTIFICATION OF IRB ACTION

Date: February 28, 2018  IRB #: CPS18-02-01
Principal Investigator(s): Brian Bicknell
Lars Sorenson
Department: Doctor of Education
College of Professional Studies
Address: 20 Belvidere
Northeastern University
Title of Project: Early Adopters of OER: Instructor Adoption Patterns for an Open Source Data Analytics Curriculum
Participating Sites: HUB of Analytics Education permission in file
DHHS Review Category: Expedited #6, #7
Informed Consents: One (1) signed consent form
Monitoring Interval: 12 months

APPROVAL EXPIRATION DATE: FEBRUARY 27, 2019

Investigator's Responsibilities:
1. The informed consent form bearing the IRB approval stamp must be used when recruiting participants into the study.
2. The investigator must notify IRB immediately of unexpected adverse reactions, or new information that may alter our perception of the benefit-risk ratio.
3. Study procedures and files are subject to audit any time.
4. Any modifications of the protocol or the informed consent as the study progresses must be reviewed and approved by this committee prior to being instituted.
5. Continuing Review Approval for the proposal should be requested at least one month prior to the expiration date above.
6. This approval applies to the protection of human subjects only. It does not apply to any other university approvals that may be necessary.

C. Randall Colvin, Ph.D., Chair
Northeastern University Institutional Review Board

Nan C. Regina, Director
Human Subject Research Protection

Northeastern University FWA #4630
Appendix D: NIH Certificate of Completion: Protecting Human Research Participants

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Lars Sorensen successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/23/2017.

Certification Number: 2238866.
Appendix E: Participant Recruitment Email/Letter of Intent

Subject Line: Research on Adoption of the HUB of Analytics Education

Dear Instructor (Name),

I am writing on behalf of Lars Sorenson, a student in the Doctor of Education program at Northeastern University. Lars is conducting a study on the use of open-source data analytics curriculum (i.e. HUB of Analytics Education) for his doctoral dissertation and would like for you to serve as a participant.

The purpose of this research is to examine the decision-making process of instructors at higher education institutions adopting an open-source data analytics curriculum in their teaching.

Participation in this study entails two interviews, both of which will cover your decision and sense making process in adopting materials from the HUB of Analytics Education in your teaching. The expected time commitment is approximately two hours via web conference in two separate interviews. Your participation is completely voluntary and you can exit the study at any time. All information gathered during the interview will be confidential and a pseudonym will be used in place of your name. All interview data will be destroyed once the study is complete.

If you are interested in participating in this study, please contact me or email Lars at sorenson.l@husky.neu.edu. Lars will contact you to provide you with additional details about the study.

Thank you for considering participation in this study.

Sincerely,

Charlie Bame-Aldred
Appendix F: Informed Consent Document

Northeastern University, Department
Name of Investigator(s): [Principal Investigator: Dr. Brian Bicknell; Student Researcher: Lars Sorenson] Title of Project: Early Adopters of OER: Instructor Adoption Patterns for an Open Source Data Analytics Curriculum

Informed Consent to Participate in a Research Study

We are inviting you to take part in a research study. This form will tell you about the study, but the researcher will explain it to you first. You may ask this person any questions that you have. When you are ready to make a decision, you may tell the researcher if you want to participate or not. You do not have to participate if you do not want to. If you decide to participate, the researcher will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?

We are asking for your participation in this study because you are an early adopter of materials that appear on the Hub of Analytics Education website. We are interested in learning more about your experience in adopting these materials for your teaching.

Why is this research study being done?

The purpose of this research to gain a deeper understanding of instructors in higher education who adopt open source materials for their teaching.

What will I be asked to do?

If you decide to take part in this study, we will ask you to participate in two interviews: the first lasting 60-90 minutes; the second, a follow-up interview, lasting approximately 30 minutes. In the first interview, the interviewer will describe the nature of the study and explain all of the precautions taken to ensure confidentiality. The substantial portion of this interview will ask you to share your experiences in adopting the open source curriculum under study. Ahead of the second interview, you will be provided a transcript of the contents of the first interview. The purpose of the second interview is to provide you with the opportunity to clarify any statements or to offer further reflections.

Where will this take place and how much of my time will it take?

Both interviews will take place via a web conferencing tool, BlueJeans. You will be asked to participate in a quiet space free of interruptions, using an internet-enabled device on a broadband internet connection, with a stable camera and microphone. The interaction will be recorded and downloaded as an mp4 video file, which will be transcribed after the interview, using Rev.com. The first interview will last 60-90 minutes. The second interview will last approximately 30 minutes.

Will there be any risk or discomfort to me?

There are no foreseeable risks or discomforts anticipated in this study. That said, the interviews may broach sensitive subjects regarding policy and colleagues at the participant’s institution. Measures taken to ensure confidentiality will alleviate the risk of the participant’s opinions becoming public.

Will I benefit by being in this research?
There will be no direct benefit to you from participating in this research. However, you may be providing valuable data to the professional practice of designing and supporting open educational resources. You may also find that by reflecting on your teaching in the interview process, you will arrive at insights that add value to your own practice.

**Who will see the information about me?**

Your participation in this study will be confidential. Only the principal investigator and student researcher will see information about you. All recordings and transcripts will be anonymized, and the final write-up will use pseudonyms to protect the identities and opinions of participants. Recordings and transcripts will be saved on a password-protected personal computer and backed up to a cloud file storage service, which will use a secure password. These files will be destroyed within three years of the conclusion of the study.

**If I do not want to take part in the study, what choices do I have?**

You are free to leave this study at any time.

**What will happen if I suffer any harm from this research?**

Because there is no foreseeable risk of harm or discomfort in this study, no special arrangements will be made for compensation for treatment based on participation in this research.

**Can I stop my participation in this study?**

Participation in this research is completely voluntary. You may quit at any time without forfeiting any rights.

**Who can I contact if I have questions or problems?**

If you have any questions about this study, feel free to contact the Principal Investigator, Dr. Brian Bicknell, at b.bicknell@northeastern.edu, 978-290-2333, or the Student Researcher, Lars Sorenson, at sorenson.l@husky.neu.edu, 603-969-7484.

**Who can I contact about my rights as a participant?**

If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, Mail Stop: 560-177, 360 Huntington Avenue, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

**Will I be paid for my participation?**

There will be no compensation for your participation in this study.

**Will it cost me anything to participate?**

There will be no direct costs to you. However, participation presumes access to broadband internet and an internet-enabled device with a camera and microphone.

**Is there anything else I need to know?**

You must be at least 18 years old to participate in this study.
I agree to take part in this research.

Printed name of person above

Signature of person who explained the study to the participant above and obtained consent

Printed name of person above

Depending upon the nature of your research, you may also be required to provide information about one or more of the following if it is applicable:

1. A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable.
2. Anticipated circumstances under which the subject’s participation may be terminated by the investigator without regard to the subject’s consent.
3. Any additional costs to the subject that may result from participation in the research.
4. The consequences of a subject’s decision to withdraw from the research and procedures for orderly termination of participation by the subject.
5. A statement that significant new finding(s) developed during the course of the research which may be related to the subject’s willingness to continue participation will be provided to the subject.
6. The approximate number of subjects involved in the study.
Appendix G: Semi-Structured Interview Protocol

**Research question:** What motivates instructors to adopt an open-source digital teaching tool?

**Request permission to record interview.**

**Say a bit about yourself.**

**Instructor Interview Protocol**

Interviewee (Pseudonym): __________________________________________________

Gender: _________________________________________________________________

Age: _________________________________________________________________

Position/Years in Profession: _____________________________________________

Institution: ____________________________________________________________

Courses in which the HUB is used: _________________________________________

Approximately when participant first discovered the HUB: ______________________

**Part I: First Interview** (60-90 minutes):

Objective: To build rapport, describe the study, describe elements included in the informed consent document, answer any questions, and allow the participant to respond to the interview questions.

**Primary Interview Protocol**

Thank you for being available to speak with me today. You have been selected to participate in this research study because you have been identified as an early adopter of the HUB of Analytics Education. If you agree, you will participate in a total of two (2) interviews. Nothing else is required of you for this research project. The goal of this first interview is to describe the study that I am conducting and to relay to you all of the precautions and safety measures that I will take to ensure confidentiality and protection of your rights as a participant, which was included in the letter of intent. We will also spend time reviewing the informed consent document. If you agree with all of the terms of this study, you will be asked to sign the document. The interview will then proceed to allow you to reflect and opine on your experiences in adopting the HUB of Analytics Education in your teaching. You will have been provided the interview questions ahead of this first interview.

The second interview will provide for follow up and will last approximately 30 minutes. It will allow you to review a copy of the interview transcript to check for accuracy and offer clarification.
My research project focuses on the motivations of instructors adopting an open educational resource in their teaching. Through this study, I hope to add to the research on the adoption and implementation of open-source digital teaching tools in higher education.

I have planned this interview to last no longer than about 60-90 minutes. During this time, I have several questions that I would like to cover. Therefore, it may be necessary to interrupt you in order to push ahead and complete this line of questioning.

I will also be taking written notes. All responses will be confidential and only a pseudonym will be used when quoting from the transcripts. My dissertation advisor and I will be the only persons with access to the recordings. Only a pseudonym will be used to label the transcripts. Do you have any questions at this time?

**Interview Questions**

1. Describe your educational and career trajectory and how it reflects your teaching philosophy.
2. Describe your current position. What factors facilitate or inhibit the adoption of technology in your teaching practice?
3. What role does digital technology play in your teaching?
4. How do you think students view your teaching practice/style, and what role does your use of technology play in this?
5. How do you define innovation in teaching in the context of adopting education technology?
6. What are some of the leading principles you apply when evaluating whether to adopt a particular piece of technology?
7. Describe how you discovered the data analytics curriculum and how you arrived at the decision to adopt it?
8. Describe your experience in teaching with the data analytics curriculum.
9. To what extent do you expect your efforts to innovate will influence your peers’ teaching practices?
10. Describe how your decision to adopt has affected 1) your students’ learning and 2) how you view your professional practice.
11. Where do you see your field headed, what trends are emerging, and how does that impact your teaching?
12. If you were to advise peers on whether and how to adopt this curriculum, what are the three most important things you would want them to know?
13. Is there anything you’d like to clarify about your experience that we haven’t covered to this point?

**Part II: Member Checking Interview** (30 minutes)
Objective: To review transcripts with participant, check for accuracy and allow for further reflection.

Second interview protocol
The purpose of this interview is to allow you to review a copy of the interview transcript to check for accuracy. It will also allow you an opportunity to clarify anything that was previously stated during your first interview.

1. Did you find the transcript to be accurate in portraying your responses?

2. Are there any points you would like to add or expand on after further reflection?