AN EXAMINATION OF THE DIFFUSION AND IMPLEMENTATION OF LEARNING MANAGEMENT SYSTEMS IN HIGHER EDUCATION

by

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CHAPTER 1: INTRODUCTION

Technologies have been offered as solutions to problems in higher education for over 100 years (Kulik, Kulik, & Cohen, 1980). Of the many technologies that came and went over the past century, few were regularly used in more than a handful of classrooms, even for short periods of time (Cuban, 1986, 2001; Cuban, Kirkpatrick, & Peck, 2001; Trow, 1997). There is, however, a notable exception. In the mid-1990s, a specific category of learning technologies was developed that was quickly adopted by almost every college and university in the United States (Arroway & Sharma, 2009). This category of learning technologies is referred to by multiple names: "course management systems," "collaborative learning environments," or "learning management systems" (Watson & Watson, 2007).[1] In this dissertation, I explore why learning management systems (LMS) diffused to the degree that they did and examine how they were used by thousands of instructors. Given the limited successes of prior learning technologies in higher education, understanding how LMSs were able to achieve wide-scale diffusion along with understanding how instructors actually use them offers an important opportunity to learn from a "successful" innovation, one that has achieved what many others have not: broad diffusion and regular use by instructors.

[1] For simplicity of presentation, I use the label "learning management system" throughout this dissertation.

LMSs support a wide range of course-related activities, such as posting assignments, managing grades, making class announcements, and exchanging digital resources, all within a comprehensive online environment. In recent EDUCAUSE surveys, over 90% of colleges and universities report deploying an LMS on their campus and over 90% of the students who were surveyed report that they have used these systems (Smith & Caruso, 2010; Smith, Salaway, & Caruso, 2009). These figures signal that LMSs diffused widely and are used regularly, something that few technologies other than Microsoft PowerPoint can claim. Most learning technologies, unlike LMSs and PowerPoint, follow a predictable life-cycle with a predictable conclusion: early inflated rhetoric, varying degrees of diffusion, and disappointing levels of use in PK-16 classrooms before finally being replaced by the "next new thing" (Becker, 2000; Collins & Halverson, 2009; Owen & Demb, 2004; Shields, 1995; Willinsky, Fischman, & Metcalfe, 2011). In what ways did LMSs diverge from this pattern set forth by so many prior technologies?

In this dissertation, I explore the different rhetorical patterns that emerged around LMSs in an effort to understand how these systems gained *legitimacy* as an innovation, where legitimacy is an enabling condition for diffusion (Strang & Meyer, 1993). Legitimacy, as Scott (2008) describes,

> is not a commodity to be possessed or exchanged, but rather a condition reflecting perceived consonance with relevant rules and law, normative support, or alignment with cultural-cognitive frameworks. Moreover, unlike material resources or technical information, legitimacy is not an input to be combined or transformed to produce some new and different output, but a symbolic value to be displayed in a manner such that it is visible to outsiders. (pp. 59-60)

Currently, the multiple surveys that have been conducted on the use of LMSs across colleges and universities (e.g., Smith & Caruso, 2010) do not draw on or specify

mechanisms that could explain LMS diffusion. Summarizing Hedstrom and Swedberg (1998), Weber and Glynn (2006), describe mechanisms as "small pieces of theory that specify how a specific input will reliably create a specific output. Mechanisms-based theorizing often builds bridges across macro and micro levels of social analysis…" (p. 1640). The ways in which LMSs gained legitimacy are plausible mechanisms for understanding the diffusion of these systems, which can be explored empirically through comprehensive analyses of popular press texts (Barley & Tolbert, 1997; Fiss & Hirsch, 2005). In this dissertation, I examine how LMSs gained legitimacy by tracing the rhetoric ascribed to these systems across sixteen years of *Chronicle of Higher Education* articles.

Zemsky and Massy (2004) argue that the excitement for technology to reform higher education is supported by three implicit propositions: (1) simply promoting an innovation will lead to its adoption; (2) students will demand innovations; and (3) innovations will force instructors to change their practices. Extant research on instructors' use of technology has generated a wide range of explanations outlining why these propositions do not generally come to fruition (Collins & Halverson, 2009; Cuban, 1986, 1993, 2001; Cuban, et al., 2001; Reiser, 1987; Tyack & Cuban, 1995; Zhao & Frank, 2003; Zhao, Pugh, Sheldon, & Byers, 2002). The same is true for LMSs, but what is unique about these systems is that they are actually used in classrooms (McGee, Carmean, & Jafari, 2005; Morgan, 2003). However, the specific ways in which these systems are used and the ways in which instructors have changed their pracitces as a result of using LMSs are not well understood. Morevover, as Lonn and Teasley (2009) argue, despite the large numbers of studies on how instructors use LMSs, few rigorously assess how these systems are *actually* used by students and instructors. Instead, most rely

on self-report measures, alone, and draw on less than representative samples of instructors. In this dissertation, I use "system log data" that track users' actual interactions with an LMS to describe instructors' deployment of LMS tools across approximately 19,000 course sites at the University of Michigan (U-M).

This dissertation, therefore, is an examination of how universities legitimated the adoption LMSs and how instructors used these systems after universities adopted them. This study draws primarily on two theoretical traditions, neoinstitutionalism from sociology (DiMaggio & Powell, 1991; H.-D. Meyer & Rowan, 2006) and implementation research from education (Fullan & Stiegelbauer, 1991). Neoinstitutionalism highlights the regulative, normative, and cultural-cognitive environmental elements that provide stability and meaning to social life (Scott, 2008, p. 48). This dissertation explores the ways in which these various elements of social life can affect the legitimacy of a diffusing innovation. Implementation research addresses the factors affecting how innovations are put to use in classrooms (Cohen & Ball, 2007; Cohen, Raudenbush, & Ball, 2003). This dissertation models several factors known to affect implementation in line with measures of users' actual interactions with an LMS.

A Different Fate for Learning Management Systems

As Cuban (1986) documents, the diffusion and use of learning technologies follows a predictable pattern: (1) exhilaration and grand pronouncements, (2) attempts at demonstrating scientific-credibility, (3) disappointment in the use and outcomes associated with an innovation, and finally (4) teacher-bashing. Multiple researchers (e.g., Abrahamson, 1991; Barley & Kunda, 1992) refer to the all-too-common fate of elevated

rhetoric and disappointing results as fad/fashion cycles, which are observable across higher education in the form of recurring efforts to develop online learning systems (J. S. Brown & Duguid, 2000; Christensen, Horn, & Johnson, 2008; Pittinsky, 2003; Selwyn, 2007) and numerous efforts to promote managerial innovations, such as Total Quality Management (Birnbaum, 2000). In this dissertation, I argue that LMSs largely avoided the pitfalls of prior learning technologies in that they were not subject to overly inflated rhetoric, which might have led to unreasonable expectations typical of the "next new thing" (Abrahamson & Fairchild, 1999). For example, in 1997, the *Chronicle of Higher Education* reported on the introduction of one of the first LMSs in the following way:

> If you visit the University of California at Los Angeles (UCLA) this summer, you might hear the furious clicking of computer keys along with some grumbling about going online. Those would be the sounds of hundreds of World Wide Web pages being built, and of even 'technophobic' faculty members learning how to use them.
>
> By this fall, the university promises, it will provide a Web page for every course in its largest unit, the College of Letters and Science. UCLA officials believe they are the first to make Web pages mandatory across an entire curriculum.
>
> The promise amounts to a revolution in the way the university views the Internet. Instead of supporting a few professors who want to put class materials on the Web, UCLA is creating an infrastructure to put information about some 3,000 courses online. (Young, 1997)

In the above quote, the idea of "a web page for every course" was seen as revolutionary, and the LMS was offered as a way to accomplish this task. As demonstrated in later chapters of this dissertation, LMSs avoided the familiar pitfalls of unreasonable expectations because other technologies were the focus of heightened rhetoric, and LMSs were couched as a way to help "manage" learning and course materials as opposed to "revolutionize" instruction in ways that other technologies were often proclaimed. The heightened rhetoric around technologies, such as the Internet, implied, among many

things, that universities needed to adopt new technologies in the interest of demonstrating that they were keeping up with the times. Throughout this dissertation, I argue that LMSs became an increasingly legitimate way for universities to respond to these increasing pressures, and as LMSs gained legitimacy as a way for universities to bring the Internet into the classroom, they were adopted in increasingly high numbers.

LMSs not only diffused across universities, they diffused within universities as large numbers of instructors adopted these systems. However, there is an important distinction between adoption and use. "Adoption" and "adopters" are terms used to distinguish among users and non-users of an innovation. These terms do not speak to how a user actually puts an innovation into practice (Coburn, 2003). Decades of research on the implementation of instructional innovations reveals that instructors use innovations in line with their preexisting practice, and absent specific interventions that move instructors to employ new instructional practices, prior ways of doing things prevail (Cohen & Ball, 2007). At U-M, instructors primarily used the LMS to post course materials and to communicate with students, which are managerial tasks made more efficient by the LMS. In line with observations from prior implementation researchers, I argue that LMSs found their way into classrooms because they provided efficiency gains to instructors without requiring changes to their underlying instructional practices in order to experience those gains.

My portrayal of why LMSs diffused to the degree that they did and how instructors actually used these systems illustrates that LMSs were a general solution to a general problem that produced general results. The problem facing universities during the mid-1990s was a need to respond to a changing technological environment prompted by

the development of the Internet. This problem was general in that little direction was given to universities in how they were actually to integrate developing technologies. Based on the ways in which LMSs were described and justified, they became an increasingly legitimate way to bring technology into university classrooms. LMSs were largely described as systems for instructors to use in managing their course materials, not to engage in ill-defined or revolutionary departures from preexisting practice. Therefore, LMSs did not challenge the status quo: they implicitly leveraged it. These systems connected with individuals' deeply held understandings of classroom instruction—courses need syllabi and readings—while offering the right amount of newness to be considered an innovation (Hargadon & Douglas, 2001). If LMSs were too radical in what they were intended to do or asked too much of adopters in order to use them, it is unlikely that they would have diffused to the degree that they did. Moreover, LMSs supported general managerial tasks that are common to instructors who teach diverse content in diverse ways. Because LMSs supported general managerial tasks, they were salient innovations to large numbers of potential users in ways that more content or pedagogically specific technologies are often not. Absent specific interventions that would help instructors use the LMSs to target instructional tasks specific to content or learning environments, there is little wonder why LMSs were used to make preexisting ways of doing things more efficient. Findings from the studies carried out in this dissertation, therefore, demonstrate that LMSs found a way to achieve what many previous technologies have not—diffuse widely and be used by many—but they also point to the tradeoffs of generality.

Research Questions

To explore the diffusion and implementation of LMSs, this dissertation is organized around the following research questions:

1. How did various actors describe and justify the use of LMSs in higher education, and in what ways did actors' descriptions and justifications change over time?
2. What are the dominant patterns in LMS use by instructors across one university?
    a. What course-specific factors help to explain instructors' use of an LMS?
    b. What instructor-specific factors help to explain instructors' use of an LMS?
    c. How do instructors' use of the LMS change over time?

To explore RQ #1, I collected and inductively coded texts from the *Chronicle of Higher Education* (CHE) to capture how LMSs became legitimate innovations for universities to adopt. To describe how LMSs were actually being used in university classrooms (RQ#2), I examined system log data that tracked instructors and students' actual interactions with an LMS at U-M.

This dissertation is organized into eight chapters. These eight chapters are arranged in line with the two research questions specified above. Chapters 2-4 describe relevant literature, data and methods, and results for research question #1, which, combined, address how LMSs were legitimated over a 16-year period. Chapters 5-7 outline relevant literature, data and methods, and results for research question #2, which, combined, assess how one LMS was used at U-M. Chapter 8 brings these two research questions together and describes the relationships between the diffusion of LMSs and their use in classrooms along with highlighting limitations associated with the overall study and directions for future research.

CHAPTER 2: OVERVIEW OF DIFFUSION OF INNOVATIONS

While learning management systems (LMS) have diffused widely—over 90% of colleges and universities in the United States report deploying an LMS on their campus (Smith & Caruso, 2010; Smith, et al., 2009)—there has been little examination of the mechanisms that enabled such broad adoption. To provide an initial set of mechanisms that could explain why LMSs diffused to the degree that they did, this chapter outlines a framework for understanding how LMSs gained legitimacy as an innovation (Suchman, 1995). As multiple scholars observe (e.g., G. F. Davis & Greve, 1997), the legitimacy of an innovation is positively correlated with its overall diffusion. Gaining legitimacy involves developing a degree of social consensus around what an innovation is (how an innovation is described) and how it addresses specific organizational failings (how an innovation is justified) (Tolbert & Zucker, 1996). How LMSs were described and justified are empirical questions. The data and methods used to explore these questions are outlined in Chapter 3.

In 1996, Murray Goldberg at the University of British Columbia in Canada introduced the first LMS, then known as WebCT. Bolstered by the belief that online learning tools helped students learn (Goldberg, 1996, 1997), Goldberg developed an online environment that supported instructors in using web-based tools with students. WebCT, Blackboard, and multiple systems to follow (e.g., Angel, Sakai, and

Prometheus), translated the seemingly simple innovation of providing instructors with a standard "template" of tools from which to choose, such as tools for managing grades, organizing course materials, and posting class announcements, into a multi-million dollar industry (Jafari, 2005). To use an LMS and take advantage of these web-enabled functions, an instructor did not need to have extensive knowledge of how to code web pages. Instead, an instructor needed only to log into a system, select a series of tools, and direct students to appropriate resources.

Developing a template of web-enabled tools not only reaped large profits for some companies, these systems, once adopted, took on the identity of "a new kind of campus building—a virtual one where online classes are held and new kinds of 'hybrid' courses take place" (Young, 2009b). The LMS, over a relatively short amount of time, became a tool used by many instructors across many universities. As more and more instructors used these systems, more and more elements of university instruction were facilitated in and through these systems. Finding course readings, grades, and course syllabi on the LMS created the following situation on many campuses: "When [the LMS] is down, it's like the door to the college is nailed shut" (Young, 2009a). Innovations that have become taken-for-granted and have achieved almost complete spread across an organizational field (DiMaggio & Powell, 1983) can be referred to as "institutionalized" innovations (Tolbert & Zucker, 1996). The processes of institutionalization are given an extended treatment in this review, and under the umbrella of institutionalization, how diffusing innovations gain legitimacy is described as a plausible mechanism for supporting the diffusion of LMSs. That LMSs, a technology conceived of in the mid-1990s, could assume such a taken-for-granted status as a "campus building" is

particularly striking when compared against the fate of the many learning technologies that preceded them.

Diffusion as a social process can be defined as the movement of an innovation within and between social systems (Rogers, 2003). As Rogers observes, an innovation is anything that can be perceived as new or novel by a target population. Canonical depictions of diffusion highlight the functional and economic advantages of innovations and regularly treat organizations and individuals as rational actors (L. A. Brown, 1981). Rational-actor approaches argue that "prescient decision makers appraise alternative practices and make optimal choices" (Strang & Macy, 2001, p. 152). In the middle-half of the 20th century, scholars from social psychology (Weick, 1969), sociology (J. W. Meyer & Rowan, 1977), and the developing field of organization studies (Simon & March, 1958) challenged then dominant notions of rationality (M. Weber, 1947). These challenges to what constitutes rational behavior influenced diffusion of innovations research (Strang & Meyer, 1993). Rationality came to be viewed not as conforming to abstract ideals of best practices (Cyert & March, 1963) but as actors' collective and individual attempts to "satisfice" (Simon, 1997) in the face both technical efficiencies and social pressures. Neoinstitutional scholars built on these developing ideas to describe how organizations operate in environments permeated by numerous taken-for-granted beliefs and practices that can shape perceptions of what counts as optimal and that can serve as alternative catalysts for organizational action (Scott, 2008).

The prefix "neo" implies an "old" institutionalism (DiMaggio & Powell, 1991). As DiMaggio and Powell explain,

> Both the old and new approaches share a skepticism toward rational-actor models of organization, and each views institutionalization as a state-dependent process

> that makes organizations less instrumentally rational by limiting the options they can pursue. Both emphasize the relationship between organizations and their environments, and both promise to reveal aspects of reality that are inconsistent with organizations' formal accounts. (p. 12)

One aspect that distinguishes old and new, or neo, institutionalism are the ways in which scholars view factors moderating optimal decision-making. Stinchcombe (1968), for example, argues that organizations do not adhere to rational-actor perspectives because individuals are motivated by self-interest and power, which can conflict with a more rational calculus. Neoinstitutional scholars, while not dismissing the role of self-interestedness, promote the idea that organizations appear less than rational because organizational actors struggle to balance the often-conflicting aims of technical efficiencies and taken-for-granted, socially shared beliefs and norms. For example, the current structure of schools and colleges—the ways in which basic features, such as instruction, are organized—stem less from efficiency considerations and more from maintaining alignment with popular notions for what constitutes schooling in the United States (Tyack & Tobin, 1994). As Meyer and Rowan (1977) observe, "Independent of their productive efficiency, organizations which exist in highly elaborated institutional environments and succeed in becoming isomorphic with these environments gain the legitimacy and resources needed to survive" (p. 352).

The difference between old and new institutionalism can also be observed in how each treats the process of institutionalization. Old institutional scholars (e.g., Selznick, 1957) argue that practices and innovations become institutionalized because individuals develop commitments to preexisting ways of doing things and that these prior ways of doing things define individual- and group-identity (Scott, 2008). On the other hand, for neoinstitutional scholars (e.g., Tolbert & Zucker, 1996), ideas, practices, and innovations

are subject to debate and social construction, whereby, "beliefs, schemas and assumptions—play a powerful role in institutional processes" (Scott, 2008, p. 127). Therefore, institutionalization from a neoinstitutional perspective is highly dependent upon how innovations are described and justified, whether or not these descriptions and justification are consonant with prior beliefs, and whether they eventually become taken-for-granted.

Neoinstitutionalism figures prominently in studies of implementation in educational organizations and has provided ready insights into why polices often fail (Coburn, 2004; Spillane, Parise, & Sherer, 2011). Cohen and Spillane (1992) observe that K-12 schools operate in highly decentralized, pluralistic environments where school leaders are increasingly tasked with making sense of and enacting nebulous policy messages. Bastedo (2007) and others (J. W. Meyer, Ramirex, Frank, & Schofer, 2007), similarly observe that universities operate in pluralistic environments where university administrators and committees are tasked with responding to multiple external and internal audiences. One implication of the decentralized nature of American higher education is that enormous pressures are placed on individual universities "to make real" the often abstract nature of policy messages and shifting societal expectations (Hill, 2001; Spillane, Reiser, & Reimer, 2002). In the United States, individual schools and universities' responses to policy are locally negotiated, as is often the case related to the purchase and implementation of technology for learning environments (Culp, Honey, & Mandinach, 2003).

As different elements of the institutional environment intersect with schools and universities, researchers have speculated that educational organizations may respond in

various ways to external pressures, such as the development of a new technology, or institutional shifts, such as new laws or shifting norms. One of the primary ways educational organizations have been characterized as responding to various pressures is through "decoupling" (J. W. Meyer & Rowan, 1977, 1978). Decoupling refers to the ways an organization—intentionally or not—signals compliance to an institutional pressure by changing an organizational structure without changing what takes place in the technical core of the organization (Thompson, 1967). Resnick and Spillane (2006) provide the following example of decoupling:

> Many education reform analyses show how institutionalization limits effective change in established organizations. Of particular note is the way in which new processes, informed by psychological research, are treated as temporary 'pilot' studies and not allowed to enter the organization's core policy or practice. In this way, education organizations can appear very 'progressive' while in fact maintaining institutionalized practices that prevent new programs from penetrating beyond a few 'experimental' sites. (p. 267)

As the above quote captures, decoupling as a strategy has multiple benefits. Schools, for example, can meet the demands of multiple audiences simultaneously (Rowan & Miskel, 1999). Decoupling, however, is only one strategy. As C. Oliver (1991) observes, organizations can acquiesce, compromise, avoid, or defy in addition to decoupling. For example, as universities face increasing pressures to provide online learning opportunities for students (Christensen, et al., 2008), universities may engage in any one of these strategies: they can readily embrace online learning in all of its forms (acquiesce), implement online learning for only certain degree programs (compromise), make no moves to embrace or defy online learning (avoid), outwardly claim no intentions of ever integrating online learning (defy), or integrate online learning in peripheral programs

(decouple), such as continuing education environments that do not provide students credit toward a degree.

While neoinstitutionalism holds a prominent position in understanding the implementation of policy initiatives in education, few empirical studies demonstrate how neoinstitutionalism can explain the ways in which instructional innovations diffuse across educational organizations (Rowan & Miskel, 1999). The current study seeks to address this underexplored phenomenon by making explicit why various innovations do or do not gain legitimacy. Furthermore, as a perspective for understanding the diffusion of innovations, neoinstitutionalism provides several reasons why organizations adopt innovations beyond those specifying efficiency gains, alone, such as what adoption may communicate about the legitimacy of the organization along with how the legitimacy of an innovation, itself, can shift over time (DiMaggio & Powell, 1983; Edmondson, Bohmer, & Pisano, 2001; Fountain, 2001; Pfeffer & Salancik, 1977; Tolbert & Zucker, 1996; Tyack & Tobin, 1994; Westphal, Gulati, & Shortell, 1997; Zbaracki, 1998).

Mechanisms Supporting Diffusion

Classic diffusion studies (e.g., Coleman, Katz, & Menzel, 1966) start with "innovations," which are, as Strang and Soule (1998) describe,

> novel (at least to the adopting community), making communication a necessary condition for adoption. Innovations are also culturally understood as progressive, strengthening the hand of change agents. And since innovations are risky and uncertain, adopters carefully weigh the experience of others before acting. The elective affinity between diffusion and innovation is so strong that we sometimes think of diffusion as the only causal process underlying the adoption pattern of innovations. Diffusion studies thus generally investigate the introduction and adoption of an innovation. (p. 267)

The various factors affecting whether innovations diffuse are multiple (Wejnert, 2002): the innovativeness of the organization (Damanpour, 1991), external communication channels (Burns & Wholey, 1993), change agents (Edelman, 1992), network ties (G. F. Davis & Greve, 1997), and the prestige of early adopters (Fligstein, 1985). An important addition to this list is the way organizations respond to changing environmental pressures (Cole & Scott, 2000). Shifting external pressures influence diffusion in that these pressures signal to organizations that they need to adapt and change; these pressures can provide a premise for organizations to adopt an innovation. The role of shifting environmental pressures highlights the ways organizations can adopt innovations in ways that need not conform to rational-actor models. As G. F. Davis and Greve (1997) note: "In many accounts, these practices are not adopted by organizations as social atoms but rather through a process of social construction by networks of managers groping to respond to changes in the legal and political environment" (p. 1). Throughout this "groping," organizations implicitly and explicitly include multiple criteria in evaluating the fitness of an innovation (Strang, 1991).

Elkins and Simmons (2005) summarize two families of diffusion mechanisms that help in explaining the ways organizations respond to changes in their environment, "those for which another's adoption alters the value of the practice and those for which another's adoption imparts information" (p. 39). Altering the value of an innovation occurs, for example, as the number of adopters for an innovation increases and an organization that has not adopted that innovation experiences increased pressure to do so (Greenhalgh, Rober, Macfarlane, Bate, & Kyriakidou, 2004). While one organization's adoption of an innovation can increase social pressure on another organization, actors can

also provide information to one another (Greenwood & Hinnings, 1996; Levitt & March, 1988). Information sharing can be facilitated by social network connections (Burt, 1992; Granovetter, 1985; Mizruchi, 1996) and multiple communication channels, such as the popular press (Strang & Soule, 1998). When information sharing is posited as a driver of diffusion, the ways in which innovations are framed can influence how potential adopters make sense of the innovation (K. Weber & Glynn, 2006). This sensemaking affects diffusion in that it can help to shape the relationship between an innovation and an external pressure: actors view the activities of others, identify consequences related to another's activities, and determine the fit of another's response to their own organizational requirements and conditions. While this scan, interpret, and act sequence (Daft & Weick, 1984) can have the appearance of rationality, the ways in which individual actors within organizations make sense of the actions of others can be idiosyncratic (Krumm & Holmstrom, 2011), driven by plausibility over accuracy (Weick, 1995), and engender superstitious learning (Levitt & March, 1988).

Whether through increased social pressure or information sharing, diffusion from a neoinstitutional perspective captures a process where organizations respond to shifting environmental pressures in increasingly similar ways (DiMaggio & Powell, 1983). What leads to consistency are the ways in which responses gain and maintain legitimacy (Abrahamson, 1991; Abrahamson & Fairchild, 1999; Barley & Kunda, 1992; Fligstein, 1985; Rowan, 1982; Strang & Soule, 1998; Suchman, 1995; Tolbert & Zucker, 1983; Wejnert, 2002). G. F. Davis and Greve (1997) elaborate on legitimacy in the following way:

> Legitimacy can be thought of as a perception or assumption that a practice meets some minimum constraint. But practices and structures do not spread simply

> because they are legitimate, but because organizational decision makers regard them as acceptable solutions to the particular problems they face. Matching problems with solutions is problematic because solutions are too abundant: managers are deluged with plausible-sounding but often contradictory 'best practices,' each with convincing evidence in the form of vivid case studies… Recognizing genuinely best practices amid this inevident welter is an imposing task, particularly given that it is almost always easier to find out whether a practice was adopted than whether it subsequently worked as advertised. (p. 7)

Institutionalization, in it basic form, is a term that is applied when innovations gain legitimacy across organizations and become taken-for-granted: as organizations experience multiple pressures through, for example, new regulations, organizations respond to these various pressures in multiple ways that can be construed as more or less legitimate (Tolbert & Zucker, 1996). Below, a process by which organizational responses gain legitimacy is described. The framework provides a way to understand how LMSs may have gained legitimacy in higher education and diffused across colleges and universities.

The Social Construction of Innovations and Institutionalization

The framework described in this section builds on the work of Tolbert and Zucker (1996), Berger and Luckman (1967), and Strang and Meyer (1993) and describes how innovations gain legitimacy as an organizational response to changing environmental conditions. This framework provides a rationale for the data and methods described in Chapter 3. In Chapters 3 and 4, texts from a single publication, the *Chronicle of Higher Education*, are used to examine how LMSs were described and justified as an organizational response between 1995 and 2011. Identifying how LMSs were described and justified provides a way to describe how LMSs gained legitimacy as an innovation, which may have affected their diffusion. The ways in which descriptions and

justifications affect an innovation's legitimacy is outlined within the broader phenomenon of institutionalization, which, as a process, is comprised of an (1) external change, (2) a response, (3) objectification, and (4) taken-for-grantedness. The role of descriptions and justifications shift throughout institutionalization; yet, they are most pronounced during objectification, where social consensus emerges around what an innovation is and the problems it solves.

An "external change" is a change that occurs outside of an organization brought on by shifts in available technologies, legislation, or market forces (Tolbert & Zucker, 1996). Greenwood, Suddaby, and Hennings (2002) refer to these external changes as "precipitating jolts," which can create new demands on organizations or limit their storehouse of responses (G. F. Davis & Greve, 1997). As Hirsch (1986) observes,

> Two taken-for-granted assumptions underlying the stability of any social institution are its participants' knowledge of the rules to be followed and their sharing of a common culture. When a disruption in the structure of institutional relations calls these into question, the individuals and groups most directly affected face the problems of (a) making sense out of experiences for which existing vocabularies may be inadequate and (b) constructing new rules of the game, or "traditions," to better map and understand their changed surroundings and in terms of which they can seek to adapt and orient their behavior. (p. 802)

The nature of a change can be large or small, dramatic or subtle. Changes can also compound and build over time (Abrahamson & Fairchild, 1999). The ways in which actors make sense of what they face, Hirsch (1986) argues, affects how organizations respond to external changes. The product of an organization's sensemaking, when shared through various communication channels can influence the diffusion of various responses (Kraatz & Zajac, 1996).

In the face of environmental changes, organizations generate responses, which "involves the generation of new structural arrangements in response to a specific

organizational problem or set of problems, and the formalization of such arrangements in the policies and procedures of a given organization, or a set of organizations that confront the same or similar problems" (Tolbert & Zucker, 1996, p. 181). Developing organizational responses are initially independent activities. As organizations generate responses and view one another, "there may be multiple adopters of a given structure, but these are likely to be comparatively few in number, limited to a circumscribed set of similar, possibly interconnected organizations facing similar circumstances, and to vary considerably in terms of the form of implementation" (p. 182). The early years of LMSs, for example, witnessed multiple universities developing homegrown systems, many of which were individualized efforts to get course materials online. Throughout their efforts to post course materials online, universities described and justified their efforts through various communication channels, such as popular and academic texts.

The ways in which various responses are described and justified is referred to as "objectification", which formally denotes "the development and specification of abstract categories and the elaboration of chains of cause and effect" (Strang & Meyer, 1993, p. 60) in relation to organizational failings and plausible solutions for those failings (Benford & Snow, 2000; Fiss & Hirsch, 2005; Strang & Soule, 1998). Objectification, in many ways, is "necessary for the transplantation of actions to contexts beyond their point of origin" (Tolbert & Zucker, 1996, p. 181). As Strang and Soule (1998) observe, objectification draws attention to the reality that innovations, alone, do not diffuse, and that "interpretive work selects and transforms diffusing practices: Not all practices can be theorized or framed, and none come out of the process unmodified" (p. 277). Said differently, an innovation needs to be "given" meaning (Berger & Luckmann, 1967;

Bijker, Hughes, & Pinch, 1987), and the language accompanying an innovation provides a window into how innovations are made sense of within organizational fields (Coburn, 2004). As organizations describe and justify their efforts and as these efforts are viewed by other organizations, a degree of social consensus can emerge related to the value of a proposed response (Benford & Snow, 2000). The specific aspects of the response that require some degree of social consensus include a "definition of a generic organizational problem, a definition that includes specification of the set or category of organizational actors characterized by the problem; and justification of a particular formal structural arrangement as a solution to the problem on logical or empirical grounds" (Tolbert & Zucker, 1996, p. 183). Specification involves describing a response in a way that is accessible to a wide audience along with describing the specific organizational failing that the response is targeting. Justification highlights the ways in which a response is thought to solve the organizational failing. Therefore, objectification is about defining a problem as well as a solution to that problem.

Objectification, in many ways, "invests the structure with both cognitive and normative legitimacy" (Tolbert & Zucker, 1996, p. 183). Legitimacy is an important element to organizational survival because it signals both acceptability and creditability (Scott, Ruef, Mendel, & Caronna, 2000). Cognitive legitimacy "points to legitimacy that comes from conforming to a common definition of the situation, frame of reference, or a recognizable role or structural template" (Scott, 2008, p 61). And normative legitimacy "stresses a deeper, moral base for assessing legitimacy" (p. 61). Increased legitimacy of an innovation may mean that it spreads more rapidly, whereas more controversial, new, and/or less legitimate innovations require more robust communication and sensemaking

(G. F. Davis & Greve, 1997; Kraatz & Zajac, 1996; Strang & Meyer, 1993). In the case of LMSs, for example, one can speculate that as these systems became more legitimate, universities were increasingly expected to adopt them as a result of conforming to a socially defined, shared understanding for responding to the need to post course materials online.

How responses gain legitimacy can be dependent upon the specific rhetorical strategies employed by actors in face-to-face communication or through various media outlets (Green, 2004). As various rhetorical strategies are invoked and as a response becomes objectified to varying degrees, different types of organizations adopt the same innovation. Yet, as adopters become more heterogeneous, the response itself becomes less so (Anderson & Tushman, 1990). As objectification unfolds, later adopters experience less flexibility in defining what the response is and how to implement it as the standardized response gains legitimacy. Zucker (1983) observes a diffusion pattern whereby early adopters of an innovation often do so for technical reasons—because it works for them—and later adopters do so for legitimacy reasons—to "keep up with the Joneses." As Westphal, Gulati, and Shortell (1997) argue, not only do later adopters adopt an innovation for reasons different from those of early adopters, later adopters also adopt a different innovation. Put simply, early adopters modify an innovation into something that works for them; later adopters, on the other hand, integrate a more standardized product in the interest of maintaining legitimacy within an organizational field and are less inclined to make modifications to an innovation (p. 371). As more and more organizations adopt a response, more outcomes, both positive and negative, are generated. These outcomes are shared, again, through multiple communication channels,

and as is the case for most responses, few become fully institutionalized, i.e., taken-for-granted. To be considered fully institutionalized, an innovation must achieve "virtually complete spread of structures across the group of actors theorized as appropriate adopters, and by the perpetuation of structures over a lengthy period of time" (p. 184). Most innovations, however, do not become taken-for-granted, and are instead deemed passing fads or fashions (Abrahamson, 1991; Abrahamson & Fairchild, 1999).

Summary

The processes of institutionalization described above—(1) external change, (2) a response, (3) objectification, and (4) taken-for-grantedness—provide one way to understand how and why LMSs diffused to the degree that they did. Diffusion is a byproduct of an "external change," such as changes in policies, norms, or shared beliefs. As these changes unfold, organizations marshal various "responses," and as organizations provide multiple responses to these pressures and view one another's actions, social consensus, i.e., "objectification," can emerge around the nature of a response and its appropriateness. Social consensus confers legitimacy on certain responses over others, which can lead to increased levels of diffusion for more the legitimate actions.

Many prior studies of LMSs document *that* diffusion occurred, not *why*. As described above, the ways in which innovations gain legitimacy provide clues for understanding why some innovations diffuse widely and others do not. This chapter provides a plausible logic model for why LMSs diffused so widely—the ways in LMS were described and justified shaped their legitimacy over time—and it also provides some direction related to possible sources of data to collect and analyze in line with this

logic model. These data and analyses, described in further detail in the next chapter, include qualitative analyses of readily available, popular texts discussing LMSs. As described in Chapter 3, texts from the *Chronicle of Higher Education* were used to examine how LMSs were described and justified since their development and subsequent adoption.

CHAPTER 3: DIFFUSION DATA AND METHODS

Despite the preponderance of evidence that learning management systems (LMS) are used on almost every college and university campus in the United States, few mechanisms have been provided to help explain why LMSs diffused to the degree that they did. One way to understand how and why an innovation diffuses is to examine how organizational actors describe and justify their adoption of an innovation. The need for organizational actors to describe and justify their adoption of an innovation can be motivated by environmental shifts that spark an organization to adapt to changing circumstances. If social consensus emerges around how a response addresses the external change, the legitimacy, and ultimately diffusion, of that innovation can increase. To capture how LMSs gained legitimacy, in this chapter, I describe how I collected and analyzed *Chronicle of Higher Education* (CHE) articles that addressed LMSs. Popular press texts, such as those from the CHE, can provide useful sources of data for examining how innovations are described and justified (Fiss & Hirsch, 2005). Data and methods described in this chapter are organized around the following research question: How did various actors describe and justify the use of LMSs in higher education, and in what ways did actors' descriptions and justifications change over time (RQ #1)?

The CHE was selected because it is one of the most recognizable publications on issues pertaining to higher education. Given its wide readership and non-technical

audience, CHE was used to identify how multiple types of actors (e.g., university administrators) described and justified the adoption and continued use of LMSs. I used a span of 16-years, from 1995-2011, to collect CHE articles because these years represent the development and diffusion of LMSs. To construct the corpus of CHE texts, generic terms as well as names for specific LMSs were used in a full-text search using the Lexis-Nexis database of all CHE articles between 1995 and 2011. The following terms represent common, generic names for these systems:

> "learning management system*", "learning content management system*", "course management system*", "virtual learning environment*", "personal learning environment*", "course management software", "personal information management", "learning management software", "curriculum management system", and "content management system".

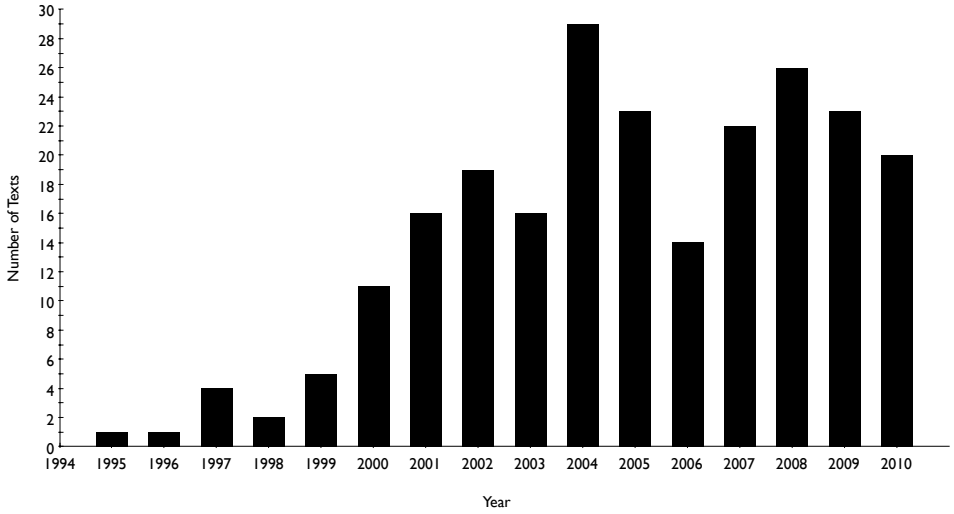
In line with generic labels for these systems, the following names of LMSs were also included:

> "WebCT", "Sakai", "Moodle", "Desire2Learn", "Blackboard", "Lotus", "CourseInfo", "Prometheus," "Angel."

Texts were selected for analysis if they had any of the above search terms present within the text. To ensure that only appropriate articles were included in the final dataset, the above search terms were highlighted within each text using search tools available within the Lexis-Nexis database. Each text was read to determine whether the highlighted search term applied to LMSs or was a false positive, which occurred frequently around the term "Blackboard." In total, 232 texts were identified for analysis. See Figure 1 for a longitudinal graph of CHE articles that comprised the final dataset. See Appendix A for a complete list of CHE articles along with the identifier given to each text used in the presentation of results in Chapter 4.

Analysis of CHE texts occurred over the following phases: (1) inductive coding for categories of descriptions and justifications, (2) development of a coding rubric, and (3) the construction of an analytical narrative using CHE texts. Inductive coding of a limited sample of CHE texts led to abstract categories that were organized into a coding rubric. The coding rubric was then used to examine all CHE texts. After coding all CHE texts, passages within a text that were highlighted during the coding phase were extracted for further analysis and organized chronologically. After organizing passages in chronological order, historical trends were surfaced using descriptive analyses of codes identified across all CHE texts. A developing narrative emerged that provided a robust depiction for the ways in which LMSs were described and justified between 1995 and 2011.

Figure 1. *Chronicle of Higher Education* Texts Analyzed Per Year



An inductive, constant comparison approach was used to develop abstract descriptions and justifications ascribed to LMSs in the initial analysis phase (Corbin &

Strauss, 2008). Descriptions and justifications were often subtle, requiring multiple coding iterations. Because subtle meanings needed to be surfaced, fewer articles were analyzed in this study as compared to rhetorical studies employing content analysis techniques (Fiss & Hirsch, 2005). A working definition for "descriptions" was developed to orient the initial coding process and later application of the coding rubric. Descriptions were defined as follows: the purposes, functionality, and/or problems ascribed to LMSs. "Justifications" were defined as the outcomes directly or indirectly cited by actors for adopting an LMS, environmental conditions discussed in relation to LMSs, and/or the problems in higher education for which LMSs were deemed a plausible solution. These definitions are consistent with those outlined by Strang and Meyer (1993), Tolbert and Zucker (1996), and Greenwood, Suddaby, and Hinings (2002) whose work on institutionalization drove much of the theoretical framework outlined in Chapter 2.

To begin the coding process, a random sample of articles, spanning multiple years, was selected to develop an initial set of categories. These categories were abstracted from sentences and paragraphs within each text. Texts were selected across multiple years in the early phases of the coding process in order to avoid developing biased codes in relation to the historical evolution of LMSs. These selected texts were used to develop an initial set of categories that were then developed into a coding rubric, which was applied and modified across the larger corpus of texts. Throughout multiple iterations, early categories formed into axial codes that helped to construct the final set of description and justification codes (Corbin & Strauss, 2008). The development of these codes is described in greater detail below. The final set of codes is presented in Table 1.

Table 1. Coding Rubric

Topic	Descriptions	Justifications
About industry or specific LMS	**Learning Environment**	Adapt to changing technological landscape
Technology use in higher education	Blended learning solution	Adapt to changes in higher education
General higher education	Total E-learning solution	Promote technology innovation
Distance learning	Distance learning solution	Increased efficiencies
New technology or service	**Functions**	Change pedagogy/learning
	Course management	Ease of use
	Integration	
	Communication	
	Problems	
	Design	
	Dependent on instructors' use	
	Cost/Support	

Note: Texts were also coded as "single mention," whereby LMSs were addressed but not described or justified to sufficient degrees that allowed for coding.

To help situate each description and justification code, a "topic" code was identified, which classified the focus of each CHE text. Initial topic codes consisted of "distance learning," "new technology or service," "about industry or specific LMS," "instructors' use of technology," "general issues in higher education," "increasing technology use in higher education," and "patent dispute." "Distance learning" addressed texts whose primary focus was on the topic of distance education or online learning. "New technology or service" addressed the introduction of a technology, such as mobile computing platforms, which were compared to LMSs or were cited as being integrated into a LMS. "About industry or specific LMS" captured texts whose primary focus was

about the many companies comprising the industry of LMSs, which included topics, such as when one company purchased another or when one system was described at length. "Instructors' use of technology" was applied to texts where, for example, an instructor described his or her decision-making around using technology. "General issues in higher education" included texts that addressed topics, such as reduced funding for universities. "Increasing technology in higher education" included texts that addressed how technology was becoming an increasingly important part of universities. Finally, "patent dispute" involved texts that addressed the legal case between Blackboard and Desire2Learn over the basic technology supporting these systems. From these codes, "about industry and specific LMS" and "patent dispute" were consolidated into one code and the distinction between instructors' use of technology and increasing technology use in higher education was collapsed into a single code, "technology use in higher education."

Three general categories of descriptions were identified, and under these general categories, specific descriptions were coded. These general categories included "learning environments," "functions," and "problems." Descriptions under "learning environments" aligned to instructional environments in which they were used, such as "distance learning" or "blended learning" environments, and when LMSs were described as a tool for supporting teaching and learning in both environments, these descriptions were coded as "total e-learning." "Functionality" of LMS codes included "communication," "course management," and "integration." "Communication" identified uses for an LMS that allowed students to communicate with one another and students to communicate with instructors. "Course management" signaled uses that helped instructors make more

efficient certain aspects of instruction, such as distributing course materials and keeping track of course grades. “Integration” addressed how the LMS could be used to access online tools outside of the LMS, for example, or to combine other information technology systems on a college campus. Initially, two other codes captured the functionality of “integration,” those of “infrastructure” and “organizational.” These two codes were collapsed into “integration” because these two codes captured a similar way in which LMSs were used to align information technologies on university campuses. A final set of description codes were identified and condensed in relation to “problems” brought on by the adoption of LMSs. Initially, problems “involved too much time to envelop courses,” “instructors’ use,” “structured/closed environment as limiting,” “content ownership,” “moving courses between systems,” “poorly designed,” “support for the company,” and “cost of the system.” These multiple codes were simplified over multiple iterations to “instructors’ use,” “design,” and “cost/support.” Lastly, a frequent way in which LMSs were described was as a “single mention,” meaning, that these systems were often mentioned in a text without further elaboration.

Multiple categories of justifications were provided across CHE texts. As coding progressed from the initial inductive coding phase to the development of stable codes that were applied to all CHE texts, justifications were condensed into the following categories: “promote technology innovation,” “adapt to changing technological landscape,” “change pedagogy/learning,” “increased efficiencies,” “ease of use,” and “adapt to changes in higher education.” “Promote technology innovation” signaled how the adoption of LMSs catalyzed the use or development of new technologies on campuses. “Adapt to a changing technological landscape” addressed how LMSs were

described in relation to technological developments, such as open source software. "Adapt to changes in higher education" included such elements as growth in online learning, financial issues facing universities, and providing students opportunities to work with modern business tools. Across coding iterations the frequency with which commentators named specific rationales were relatively few. However, multiple external shifts, such as those under "adapt to a changing technological landscape" "adapt to changes in higher education" were frequently mentioned. A majority of justification codes, in the end, captured this external-shift component.

The above codes were compiled into a coding rubric, which was then used to examine all CHE texts. Refinement of the codes, such as the various codes that were collapsed, occurred during the use of the rubric. The above codes were arrayed in columns across a Microsoft Excel spreadsheet and each CHE text was placed in its own row. Texts were read multiple times, in their entirety, and passages that evidenced one of the categories were highlighted and marked on the coding rubric. These highlighted passages were then re-read and organized in chronological order. In conjunction with patterns identified from descriptive analyses related to the number of codes identified across CHE texts, these highlighted passages were developed into an analytical narrative describing the ways in which LMSs gained legitimacy over a 16-year period.

Summary

The ways in which innovations gain legitimacy, drawn from the sociological tradition of neoinstitutionalism, provided a set of mechanisms that were operationalized using historical data from the popular press publication, the CHE. Gaining legitimacy, as

part of a larger process of institutionalization, captures how organizations respond to external pressures and describe their efforts through various communication channels. The CHE was selected to examine this process because it is one of the most widely read publications on issues pertaining to higher education. Moreover, the CHE addresses a wide range of topics, not just issues related to technology. Given this broad focus, how LMSs were described and justified in this publication, arguably, represents mainstream discourse around LMSs in higher education. To capture this discourse, CHE texts were inductively coded to identify how LMSs were described and justified throughout their diffusion and continued use (RQ #1). The above data and methods rely on the fact that LMSs are documented to have diffused widely. Drawing on insights from neoinstitutionalism and longitudinal data, the above methods provide one of many ways to identify *why*.

CHAPTER 4: DIFFUSION RESULTS AND DISCUSSION

Learning management systems (LMS) represent one of the most widely diffused technologies in higher education. Recent figures estimate that over 90% of universities use an LMS on their campus (Smith & Caruso, 2010; Smith, et al., 2009). First released in the mid-1990s, LMSs have not only achieved widespread diffusion, they did so in a relatively short amount of time. How and why these technologies were able to achieve this level of diffusion is currently not well understood. As the previous chapters argued, one way to understand how and why an innovation diffuses is to examine how organizational actors describe and justify their adoption of an innovation, whereby consensus around the appropriateness of an innovation can affect both its legitimacy and diffusion. This process, in general terms, is referred to as institutionalization, which captures how innovations become socially constructed and taken-for-granted over time. *Chronicle of Higher Education* (CHE) articles were analyzed because these types texts can be used to identify dominant discourse patterns around the ways in which innovations are described and justified (Fiss & Hirsch, 2005). In this chapter, I present results related to how LMSs gained legitimacy between 1995 and 2011 (RQ #1). Results related to how LMSs gained legitimacy are organized into two parts. The first part provides a chronological analysis of overarching themes. This chronological analysis is organized around key passages from CHE texts identified during inductive coding. Following this, a

full presentation of the diversity with which LMSs were described and justified is presented.

As the following analyses demonstrate, LMSs were described and justified in distinct ways across a variety of topics. Three main features of CHE texts were coded: (1) the topic of the CHE text, (2) how LMSs were described, and (3) how LMS were justified. LMSs were discussed in line with topics, such as distance learning. Across these topics, LMSs were either mentioned with no supporting description or justification, were described to some degree, and/or were justified in terms of their adoption or continued use. Of the 232 CHE texts, 148 (63.8%) texts provided at least one description and 123 (53%) texts provided at least one justification. Given the topics under which LMSs were discussed and the consistency with which these systems were described and justified, this chapter provides empirical support for the proposition that the diffusion of LMSs was supported by their ability to help universities respond to external pressures along with supporting universities in making sense of how generic technologies, such as the Internet, could be deployed in classrooms.

Chronological Narrative

In the narrative that follows, I argue that LMSs gained legitimacy as a pragmatic tool that helped universities respond to multiple external pressures. The external pressures that universities were attending to, in general, involved the rapid development of multiple technologies that outside parties argued universities needed to adopt. Calls for adopting various technologies reached a high point as the Internet and online learning were framed as revolutionary developments both inside and outside of universities

(Dreyfus, 2001; Nespor, 2006). The ways LMSs were described and justified supported their rise in legitimacy in that LMSs provided concrete responses to multiple calls for integrating more and more technology on college campuses. LMSs, in line with the ways in which they were described and justified, made concrete the abstractness associated with integrating technologies into learning environments because they provided a way to minimally bring the Internet into classrooms along with signaling to multiple audiences that universities were keeping up with developing technologies. As a concrete response to the often ill-defined pressure to integrate technology, however, LMSs came with both benefits and tradeoffs. As a benefit, these systems were not only concrete responses, they were technologies that were also easy to use and offered instructors real gains in terms of efficiencies. Moreover, LMSs provided a basic infrastructure for integrating multiple technologies and university services. As a tradeoff, these systems came with what some saw as limitations and design flaws. Starting in 1995, these benefits and tradeoffs along with the ways in which LMSs were described and justified are presented below.

The Early Years: 1995-2000

LMSs were first mentioned in the CHE in 1995 when New York University (NYU) announced that it would use Lotus Domino software to provide access to videos of course lectures to students who were studying in locations off-campus. Lotus Domino was an early form of "groupware," which provided organizations with digital tools to support collaboration among groups and teams (Orlikowski & Hofman, 1997). Providing students access to materials through NYU's teleprogram, argued Richard Vigilante,

director of the Information Technologies Institute and founder of the Virtual College, allowed students,

> to work with the tools of modern business-information systems as they learn about them. He says home-based students will receive 'the same level of dynamic, visual, and hands-on instruction that characterizes the best on-campus lectures, seminars, and laboratories' (C1, 1995).[2]

Vigilante, in the same CHE text, went on to argue that,

> The software forces instructors to rethink how they should teach their courses for a seminar-like format that depends heavily on encouraging students to work with one another in small groups (C1, 1995).

In this later quote, one of the three assumptions of e-learning outlined by Zemsky and Massey (2004) surfaces: using technology will force instructors to change their practices. Along with this allusion to later e-learning innovations, early discussions around Lotus also signaled how LMSs would later be described as systems for managing course resources.

In 1997, the first system to be later called an LMS, WebCT, was announced in the CHE.

> While many social-science professors have embraced technology in the classroom, teaching courses over the Internet remains largely the domain of computer scientists and other technologically savvy professors.
>
> But a computer scientist at the University of British Columbia has designed computer software that could help professors create on-line examinations, electronic class discussions, and other course materials on the World-Wide Web as easily as they write syllabi.
>
> The set of programs, called WebCT (for 'Web Course Tools'), lets instructors design on-line courses through a series of simple forms accessible via the Web.

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[2] Notes in parentheses correspond to *Chronicle of Higher Education* texts analyzed for this study. A full list of articles is organized in Appendix A. "C1" corresponds to a specific CHE text found in that table.

> By entering their own material into the program's forms, they can create Web sites that serve many of the same functions as class meetings.
>
> Once the virtual classroom has been built, students receive accounts that give them access to functions as simple as an electronic syllabus and lecture notes, or as complex as live discussions and grade-tracking tools. Professors can incorporate as few or as many of these features as they like into their courses.
>
> The system also allows for online class discussions that, in the style of computer bulletin boards, consist of students' contributions to 'threads' of dialogue on topics relevant to their studies. Using those discussions, which take place over time, or 'chat forums,' which are live, students can get help from their instructor or classmates. Professors can even administer exams on line; the program keeps track of their duration, to prevent students from taking more time than allowed. Later, students can check back to get their grades. (C4, 1997)

As with the announcement of NYU's teleprogram using Lotus Domino, several later trends related to the ways LMSs were described and justified are observable in the above announcement. For example, five descriptions can be found, such as "blended learning environments," "communication," and "course management" tools as well as tools that are "dependent on instructor's use." The justification of "ease of use" is also apparent. These early descriptions and justifications also signal the relatively mild rhetoric accompanying these systems. Unlike some innovations, such as the computer or the Internet, documented by Cuban (1986; 2001) and others (e.g., Dreyfus, 2001), WebCT was not portrayed as revolutionizing higher education. Instead, as witnessed below, it was the Internet, not LMSs that would revolutionize university classrooms.

In the same year, the University of California, Los Angeles (UCLA) announced that the largest college on its campus, the College of Letters and Science, would provide a web page for every course. To support this endeavor, UCLA selected WebCT. As reported in the CHE text making the announcement,

> The promise [to create a web page for every course] amounts to a revolution in the way the university views the Internet. Instead of supporting a few professors

> who want to put class materials on the Web, UCLA is creating an infrastructure to put information about some 3,000 courses on line….
>
> Some professors fear that maintaining their Web pages will take too much time, and that students might find so much information online that they won't bother coming to class. But administrators say the changes will let the university take full advantage of the Internet. They say the costs of the project are outweighed by the benefits the Web can bring to students-fostering discussions with classmates and faculty members, providing a one-stop source for course materials, and letting students explore a global collection of educational materials (C5, 1997).

In this later quote, LMSs were positioned as a response to changing technologies, such as the Internet. Using an LMS, stated simply, allowed universities and instructors to "take full advantage of the Internet." How universities were to take advantage of the Internet was made concrete in the activities of accessing course materials, which was both an early and consistent description for how LMSs could be used. As the appetite for putting materials online grew, universities, such as the University of Iowa, were working to incentivize instructors' use of such systems by providing grants and workshops (C6, 1997).

As universities worked to understand the potential role of the Internet, they viewed one another and read about one another's responses, such as UCLA's efforts to put all courses online, across multiple media outlets. As one CHE text stated,

> Faculty members at many institutions have been caught in a mad dash to enhance their courses with on-line materials and activities. Some professors have taken a do-it-yourself approach, designing World-Wide Web pages from the ground up. Now a fledgling industry, made up of software developers, academic technologists, and instructors, is springing up to help faculty members put their courses on line without having to learn the intricacies of page coding. (C7, 1997)

As pressures mounted to integrate the Web on campus, how this would happen was far from obvious, and universities attempted multiple strategies, such as providing instructors software and professional development workshops in building their own webpages

(Nespor, 2006; Zemsky & Massy, 2004). As LMSs and groupware were introduced, universities found yet another way to bring the Internet into classrooms. An early selling point of LMSs, as the above quote captures, is that these systems could not only help universities find a way to take advantage of networked computing but that these systems could do so in an easy to use package. As the following quote reiterates:

> But the central selling point of most of the software packages is that they allow faculty members to create Web pages for their courses without needing to know HTML. They simply fill in the blanks, and the program produces a Web site. Dr. Milheim [professor of education at Pennsylvania State University's Great Valley Graduate Center] warns, however, that the programs can be limiting: The course templates they provide might not match the way professors want to teach.
>
> He also says the pages can have a cookie-cutter look. 'The good side of that is that it's easier for the faculty member to develop it. You've got 10 templates to choose from-pick one. It probably doesn't matter to the student in the long run what that template looks like.'
>
> The design of most course-development tools makes them easy on university information-service departments as well. Most of the tools require no special software for professors or students, relying only on conventional Web browsers. The software typically runs on standard Web servers with Unix or Windows operating systems. Some software vendors offer the use of their own servers to professors who do not have access to a university network. (C7, 1997)

The above quote highlights a consistent tension for LMSs. In this quote, the tension between ease-of-use, which has obvious appeal, was juxtaposed with the limitations of easy to use software: in order to reach large numbers of instructors, certain tradeoffs needed to be made, and these systems were often characterized as being designed for the lowest common denominator.

Online Learning and the Reinvention of the LMS: 2000-2005

In 2000, the CHE reported on how Internet-based companies providing services to colleges and universities met with severe financial troubles following the dot-com

bubble. One of the few services to survive the maelstrom were LMSs (C22, 2000). One possible reason why LMSs succeeded is that they provided universities a concrete way to bring the Internet into classrooms. A further reason is that LMSs provided an important set of infrastructure for supporting a developing trend in higher education—online learning. Teaching online was seen as a way for universities to extend their reach to students as well as to increase their revenue (Nespor, 2006). While LMSs provided a way to support the various aims of online learning, most universities continued to adopt these systems for on-campus courses (C30, 2001). For many universities, bringing the Internet into the traditional university classroom was the aim, not creating virtual classrooms. However, for some universities, the idea of the virtual classroom took on various forms, some of which whetted the appetite for online learning, such as MIT's announcement of its Open Courseware Project (OCW) (C31, 2001). The OCW was followed up by the Open Knowledge Initiative (OKI) (C33, 2001), which was an attempt by universities to develop standard technical protocols for universities so that a "course" in one LMS could be read as such in another.

As pressures to provide online courses mounted and collaborations to build a better LMS formed, conversations continued about what the LMS is and its value for universities and instructors:

> The systems spare faculty members from having to photocopy and distribute course packs, and mean that students don't have to hike to a professor's office to look up grades that were posted on the door, or call classmates to ask about the next reading assignment. Such features simplify the administrative tasks of teaching and learning, even if, as some critics say, they don't improve a professor's actual teaching or students' learning. At many colleges, not all faculty members use the systems, and in any case their usefulness depends largely on how much effort is put into giving them helpful features.

> ‘The definition of the problem we’re trying to solve has changed,’ says Matthew S. Pittinsky, chairman of Blackboard Inc. Courseware is evolving quickly, he says, from a set of relatively simple tools used to enhance a professor’s individual course Web site into large-scale integrated information systems that are used for both campus-based and distance education—by an entire campus or system of campuses or a consortium of colleges. (C42, 2001)

Pittinsky’s comments signal the ways LMSs help instructors manage their courses materials and how these systems could be integrated into multiple types of learning environments. Helping instructors to manage course materials,

> have made [LMSs] exceptional productivity tools for handling the administrative tasks of teaching, says Michigan’s Mr. Berger. ‘What has really surprised us is that the productivity has been realized, not only by the faculty members, but even more by the students.’ Students, he adds, have ‘more and more that they’ve got to learn in less and less time, and so they benefit from having their learning environment be organized.’
>
> Nonetheless, by handling some of a professor’s more onerous administrative tasks, the new systems can have a beneficial effect on teaching and learning. ‘I’ve been able to spend more time focusing on the kind of things I like to focus on in class, and less on administrivia,’ says Mr. Berger, who teaches science and technology education courses at Michigan.
>
> When colleges introduce course-management systems, they may see pedagogical gains because professors often have to redesign their courses before they can put them online, says Diane J. Davis, director of the Center for Instructional Development & Distance Education at the University of Pittsburgh. ‘That process alone leads to increased quality,’ she says. (C42, 2001)

While LMSs as course management tools were suggested to have benefits for both instructors and students, questions about getting the most out of these systems began to mount, and calls for new features to be integrated into the LMS gained momentum. This momentum came from the reality that many universities adopted these systems and were looking for ways to increase their utility on campus and get closer to promoting the changes in teaching and learning that were not occurring:

> But some educators say that the evolution of course-management systems could change all of that. Mr. Berger, at Michigan, describes today’s systems as

> precursors of what he calls 'the real killer app' for higher education. Many pieces of it exist already, he says—courseware, portal software, and electronic portfolios, for example. A standard Web language like XML will be an essential component of any future system capable of handling 'all of the exotic data sources' that students and faculty members need for learning and research, he says.
>
> Ms. McKenna, at Lesley, says it is apparent to her that WebCT and Blackboard were developed, for the most part, 'by engineers and technology folks, not by educators.' To be more useful, she says, the systems should be capable of continually assessing what students already know, what they don't know, and what they are interested in. (C42, 2001)

The above quotes, in total, highlight the ways LMSs met important needs of instructors and provided an initial toehold for online technologies in university classrooms. Yet, despite the apparent success of these systems as providing utility in managing course materials and helping universities cope with shifting external pressures to integrate technology, many commentators wanted more from these systems.

Along with wanting more, universities wanted to do so for less. In 2002, academic administrators began to voice concerns over the price of LMSs. As one CHE text reported on Blackboard's price increases, "Seton Hall's bill for the software rose about 15 percent after the pricing changes. 'The university's courseware system is one of our mission-critical systems, yet it costs a very small fraction of our overall IT budget,' Mr. Landry [Chief Information Officer at Seton Hall University] said in an e-mail discussion" (C48, 2002). While LMSs, for some universities, made up a small fraction of overall budgets, any increase in technology expenditures were not welcomed. As Vivian Sinou at Foothill College in California argued, many universities were "being held hostage to the industry, and the costs are only going up" (C66, 2003). Moreover, despite increased pressures to supply more technology, many universities saw their technology budgets as an easy thing to cut. Though cost-cutting became a salient feature for universities, some

systems, as the above quote signals, were deemed "mission-critical." Among these mission critical systems, such as email and enterprise resource planning software, LMSs were among the few to be used in university classrooms.

Cost, getting more out of LMSs, online learning (C52, 2002), and changing technologies converged in conversations around the University of Michigan's announcement that it was reworking its homegrown LMS into an open source system (C60, 2002). The newly revised LMS was also going to support the newly developed (and developing) standards promoted by the OKI. By re-writing the LMS to incorporate new standards, U-M's "CourseTools" was intended to support a greater degree of "pedagogical experimentation." Similarly, Foothill College announced that it would develop its own LMS, under the following logic:

> 'Younger instructors who are quite comfortable with the Web want to do things that are impossible with the current Etudes,' Ms. Sinou says. For example, they would like a system that could link a student's electronic transcript to an electronic portfolio of the student's work -- research papers, artwork, and the like. Most online-learning systems lack student services, such as tutoring, help-desk support, and academic counseling. 'All of that could be integrated, and those are some of the areas that we are exploring,' Ms. Sinou says. (C66, 2003)

These areas of exploration that were being attempted in "newer" LMSs signaled that LMSs in 2003 were not meeting expectations. Surprisingly, however, the expectations for what LMSs could deliver were not overly optimistic. If optimism did abound it was in relation to the Internet and related online technologies. The Internet was to change higher education, not LMSs. Though, for many IT administrators, the LMS was a concrete way to organize and support bringing online technologies into college classrooms. As Sinou's comments illustrate, the LMS was a central IT platform for integrating many functions.

In 2003, one of the first comprehensive analyses of LMS use was published in an EDUCAUSE Center for Applied Research report (Morgan, 2003). In this report, Morgan identified the increasing popularity of these systems on college campuses. Based on her team's large survey, interview, and system log data analyses, Morgan identified that most LMS use was concentrated in instructor's use of content management tools. In this report, the LMS was characterized as a pragmatic tool serving the pragmatic ends of instructors. The CHE reported on Morgan's findings in the following way:

> Professors at many universities say that course management software helps them organize their courses better and brings new levels of interaction both among students and between students and professors. The Wisconsin study sought to test that hypothesis by asking what professors really think about the software.
>
> According to the study, faculty members find course-management systems time-consuming and inflexible, and students find them difficult to use. Some faculty members in the Wisconsin system reported that their students actively discourage the use of course management systems.
>
> A report on the study, 'Faculty Use of Course Management Systems,' confirms that the software is becoming ubiquitous as a classroom tool—not just in online learning, but also in otherwise traditional face-to-face courses. In fact, 80 percent of the faculty members in the survey who use the software apply it primarily to traditional courses. (C76, 2003)

In the above quotes, the theme of LMSs as supporting instructors in managing course materials is highlighted. This time, however, these descriptions were supported by a large-scale analysis of LMS use at the University of Wisconsin.

In 2004, a dominant theme related to a changing technological landscape emerged in the form of open source software. Much like the rhetoric associated with integrating the Internet into more and more university activities, open source software was cast as an *a priori* good in and of itself. Open source software was framed in terms of promoting customization, innovation, and cutting costs. With the growing popularity of open source

software, Moodle, an LMS developed in 1999 and the newly formed partnership, Sakai, rose to prominence. Through the lens of Moodle and Sakai, LMSs in general were framed in terms of what open source technologies could bring to these systems.

> What appeals most to us about Sakai is the open nature of the code and architecture, which means we can expand it into more than a course-management system. It can serve as a framework for lots of tools for teaching and learning, and we can thoroughly integrate it with our portal. We didn't choose Sakai to save money. Instead we hope the open source nature of the code will let us break out of the constraints imposed by vendors, who supply only certain tools in their course management systems (C119, 2005).

Also claimed during this time were the ways in which open source software, in general, was close to customers, i.e., faculty, who could also participate in the development of their own web-based tools. As Robert Lowden, vice president for information technology at Indiana University, Indianapolis stated: "colleges have direct access to professors who submit feedback and ideas for features. The trick will be to harness that resource, he said, adding, 'we can hire 12,000 faculty members as advisers'" (C99, 2004). While LMSs provided a way for university administrators and faculty to make sense of the Internet, so too did LMSs help these same individuals make sense of open source software. Similar to the Internet as well are the ways in which any elevated rhetoric that occurred around LMSs was in direct relation to open source software, in general, and not LMSs.

The Next Generation of LMSs: 2005-2011

Chuck Powell, director of academic media and technology at Yale University, in 2006, summarizes the ways LMSs were becoming taken-for-granted on college campuses in the following way:

> Now if the system goes down at 4 on a Tuesday morning, e-mail messages flood in complaining that lives (and, more important, grades) are being ruined. Inability

> to log on to the system two minutes before class starts might be grounds for canceling a lecture. Faculty members count on the system to deliver disparate tools, including lab notebooks and required readings; administrators want to use e-mail, chat, and discussion tools for tasks like managing committees; and students rely on it for improved access to their institution's libraries and museums. The better the system, the more people want to use it, and the more tasks they want it to accomplish. (C116, 2005)

As LMSs became more integral to university activities, competition among LMS providers intensified. By 2006, universities could select from open source options, such as Moodle or Sakai, or from commercial vendors that were engaging in increased market consolidation. In 2006, Blackboard sued rival LMS maker, Desire2Learn for its alleged infringement on Blackboard's patent. The merits of Blackboard's case hinged on 44 functions that it claimed to have invented. One functionality, "the method of giving a single user predefined roles in multiple online courses" was the most heavily contested and one that sparked a great deal of unrest, not just for LMS producers, but for colleges and universities who were purchasing technologies that allegedly infringed on Blackboard's patent (C142, 2006).

The regular undercurrent of discontent related to the design of LMSs also resurfaced as new technologies were introduced under the banner of "Web 2.0" technologies. Web 2.0 technologies, such as Blogs and Wikis, gave end users the ability to edit and produce, not just consume content online. LMSs, through the lens of these new software, were cast as mere vehicles for consumption.

> The problem is not the idea of a course-management system itself—a basic set of tools for content delivery, evaluation, and communication—nor the various uses of such systems, many of which serve their purposes quite well. Rather, the problem is that most course-management systems were developed at a time when the Internet was seen primarily as a mechanism for information delivery. Course-management systems were not created to enhance learning, but to make it easier for a faculty member to deliver materials to students. Even though most of the systems now include basic tools that allow students to turn in assignments, take

> exams and surveys, and communicate with each other through discussion boards and chat programs, those tools tend to be limited in functionality, generic in form, and based on relatively old technology. (C147, 2007)

However, a familiar theme emerged in relation to these new technologies, LMSs again found their way into discussions on technology's role on university campuses. Features of LMS design, for example, were thrown into relief in the following ways:

> My IT colleagues often observe that what course management systems like Blackboard do well is deliver material. Here's your stuff: Read it, absorb it, review it. What the systems do not do well is facilitate interaction. Here are your peers and teachers: Listen, talk, challenge, answer, try, fail, try again. Both the true liberal-arts curriculum and the online world are examples of revolutions in communication. We have to figure out how to use the latter in service to the former. (C178)

As universities grappled with Web 2.0 technologies, the LMS was described as a ready infrastructure for integrating these features (C188, 2008).

As the above narrative demonstrates, LMSs played an important role in helping universities to integrate and make sense of multiple technologies. One of the most frequently implied pressures facing universities was the need to use more technology on campus. Examples of these technologies included the Internet, open source, and Web 2.0 technologies. Accompanying these technologies were thoughts on how universities were to use them. One example, which was coded as a "general changes in higher education," included the growth of online and distance learning opportunities. As various technologies and changes in higher education manifested, LMSs were justified as concrete responses to these external pressures. In the section that follows, the full range of codes that were identified across CHE texts are identified. The diversity of codes adds nuance to the narrative presented above in that the frequency of codes highlighted in the

chronological narrative are described in relation to all topics, descriptions, and justifications highlighted in relation to LMSs between 1995 and 2011.

Topics Under Which Learning Management Systems Were Discussed

To contextualize the above narrative, the three main aspects of each CHE text that were coded are described below. As noted in the previous chapter, the various topics under which they were discussed were coded along with various descriptions and justifications. Topic codes provided clues as to the full range of issues under which LMSs were discussed. Moreover, topic codes provided a way to examine whether descriptions and justifications varied among issues (e.g., Were certain descriptions for an LMS only made in relation to one topic?). In line with these purposes, the following overview addresses the number of topics under which LMSs were discussed. LMSs were mentioned across five topics: (1) distance learning, (2) introduction of a new technology or service, (3) the LMS industry, (4) technology use in higher education, and (5) general issues in higher education. In order to be coded under the "distance learning" topic, for example, the primary purpose of the article needed to be about distance learning. By extension, the topic code "new technology or service" similarly was applied to texts whose primary purpose was describing a new technology. Table 2 presents all topic codes along with their frequency across CHE texts.

LMS Industry. The most prevalent topic under which LMSs were discussed addressed LMSs themselves, as an "industry" or as specific platforms, such as WebCT or Blackboard. Texts addressing the LMS industry made up 34.5% of all texts (N=80). In 1997, the first systems to be referred to as LMSs were introduced (C4, 1997). As early as

2000, issues related to developing technological standards that supported interoperability among various LMS providers were discussed (C18, 2000) and the idea that LMS providers constituted an industry emerged (C20, 2000). Companies purchased one another and the general profitability of LMS providers became more widely acknowledged (C39, 2001; C53, 2002). In 2002, the issue of pricing emerged as multiple universities began to question the steep costs of both WebCT and Blackboard (C48, 2002). In 2004, open source technologies rose to prominence, especially in relation to the Sakai project (C81, 2004; C99, 2004). Many of the post-2005 texts that focused specifically on the industry or LMSs dealt with three issues: (1) the role of open source alternatives, (2) technology patent cases, and (3) new alternatives to the LMS. Many of these issues intersected as open source LMSs, such as Sakai, were thought to be targets for patent litigation.

Technology Use in Higher Education. The CHE regularly spotlighted the role of technology in higher education. For example, in 1997, the University of Iowa was identified as a university that provided instructors multiple professional development opportunities and incentives to participate in these opportunities (C6, 1997). Other topics included retrospectives on the role of Web 2.0 technologies in higher education classrooms (C147, 2007) and how various universities were deploying blended learning opportunities (C227, 2010). Texts that addressed technology use made up 20.3% of all CHE texts (N=47).

General Higher Education. Given the general focus of the CHE, as a topic, "general higher education" was applied to a number of texts (N=41, 17.7%). For example, this topic captured texts that described issues such as professors being paid to

adopt textbooks (C73, 2003) and the role faculty might continue to play on campus as new technologies and online course offerings emerged (C209, 2009).

Distance Learning. LMSs were discussed in terms of distance learning 39 times, representing 16% of all CHE texts. Examples within this topic included NYU's development of a content management system using Lotus Domino software, which was one of the early infrastructures for LMSs (C1, 1995). In 1999, LMSs were discussed in line with online MBA programs (C12, 1999) and the general growth of the distance education market (C14, 1999). Between 2000 and 2008, the relationship of LMSs to distance learning involved the development of different software standards to support distance learning providers (C52, 2002) and the design limitations of WebCT for distance learning students (C118, 2005). In 2009 and 2010, when distance learning as a context included the most CHE texts, much of the discussion involved the multiple costs and benefits of distance learning to universities. As many commentators noted, LMSs had become critical infrastructure supporting many distance learning initiatives.

New Technology or Service. LMSs were frequently discussed in relation to a new technology or service being introduced. The new technology was not the LMS, itself, but a new technology that existed outside of the LMS. LMSs were either used as a comparison for a technology, such as blogs (C117, 2005), or were cited as benefitting from a technology, such as a new authentication technology, "Shibboleth" (C69, 2003). Texts that primarily addressed a new technology or service comprised 25 (10.8%) of CHE texts.

Table 2. Frequency of Topic Codes

Topic	Frequency	Percent
About industry or specific LMS	80	34.5
Technology use in higher education	47	20.3
General higher education	41	17.7
Distance learning	36	16.8
New technology or service	25	10.8

How Learning Management Systems Were Described

As demonstrated above, LMSs were discussed across multiple topics, with most discussions occurring around texts whose primary focus was on LMSs themselves. As previously noted, 148 texts provided a recognizable description for LMSs. Approximately one-third of these 148 texts (N=69) provided multiple descriptions. In total, 215 descriptions were identified. Sixty texts from the entire corpus were classified as "single mentions," which captured texts that included one of the search terms described in Chapter 3, but did not contain robust descriptions or justifications. Single mention codes, therefore, had salience given the topic under which LMSs were mentioned; yet, these texts did not provide a formal description and/or justification for further coding. LMSs were described in three general ways, (1) in line with generic learning environments, (2) related functionality, and/or (3) as a technology that came with certain problems. Within these three categories, three general learning environments were identified (distance learning, blended learning, and total e-learning), four related functionalities surfaced (communication, course management, integration, and infrastructure), and three problems were raised (design, cost, and content ownership). Table 3 presents the frequency counts for each description code and sub-code.

Learning Environments as Descriptions for Learning Management Systems

Across 20 CHE texts, LMSs were described as general tools in relation to generic learning environments. These learning environments included blended learning (4%), total e-learning solutions (3.5%), or distance learning (2.5%). Learning environment related descriptions, in total, comprised 10% of all descriptions. These descriptions were applied across multiple contexts, largely concentrating, however, on texts whose primary topic was on LMSs and the LMS industry.

Blended Learning. A small number of texts described LMSs as blended learning tools. These descriptions assumed an instructional use for LMSs as supporting how teachers teach and students learn in traditional higher education settings, such as lectures and seminars, but with an online component supported by the LMS. This online component often involved students accessing resources, instructors communicating with students, or instructors managing grades and assignments through the LMS. Combined, eight texts described LMSs as generic blended learning tools, making up 4% of all descriptions.

Total E-Learning. When both distance learning and blended learning environments were used to describe the LMS, the code "total e-learning tool" was applied. For example, in C42 (2001), LMSs were described in the following way:

> 'The definition of the problem we're trying to solve has changed,' says Matthew S. Pittinsky, chairman of Blackboard Inc. Courseware is evolving quickly, he says, from a set of relatively simple tools used to enhance a professor's individual course Web site into large-scale integrated information systems that are used for both campus-based and distance education—by an entire campus or system of campuses or a consortium of colleges.

Much like the above learning environments descriptions, the total e-learning code made up a relatively limited number of CHE texts, 3.3% of all texts with a description.

Distance Learning. Across five texts (2.5%), LMSs were described in various ways that could be generalized as a distance-learning tool. The description code of "distance learning" is different from the topic code; the description code of "distance learning" was used when explicit mention was made of LMSs as supporting distance learning irrespective of the topic of an article.

Description codes that characterized LMSs as tools to be used in specific learning environments made up a relatively limited number of codes. The limited number of texts with learning environment codes signals that LMSs were predominantly described in other ways. Below, the largest collection of description-codes, "functions," are outlined. The number of descriptions under this code signals that LMSs were predominantly described in relation to what these systems could do.

Table 3. Frequency of Description Codes

Description	Frequency	Percent with Description Code	Percent of All CHE Texts
Learning Environment			
Blended learning	8	4.0	3.4
Total E-learning	7	3.5	3.0
Distance learning	5	2.5	2.2
Functions			
Course management	60	30.2	25.9
Integration	54	27.1	23.3
Communication	18	9.0	7.8
Problem			
Design	28	14.1	12.1
Dependent on instructors' use	10	5.4	4.3
Cost/Support	9	4.5	3.9

Functions as Descriptions for Learning Management Systems

A majority of descriptions related to LMSs captured an aspect of their function, which comprised three generic types: (1) course management, (2) communication, and (3) integration. These functions were more specific than the generic learning environments captured by the above descriptions. "Course management" as a function aligned with uses for the LMS, such as posting grades and accessing resources (30.2%). "Integration" dealt with the ways in which multiple online tools outside of the LMS could be plugged-into an LMS or the ways in which the LMS sat in the background as basic infrastructure (27.1%). "Communication" named specific tools that supported interactions between and among students and instructors (9%). Descriptions that highlighted these three functions made up 66.3% of all descriptions.

Course Management. The description of LMSs as course management systems denotes specific mentions of the LMS as providing students with access to course materials and posting grades. Course management was different from communication in that the description "communication" captured the ways in which the LMS was used to support instructional interactions between and among instructors and students. LMSs described in terms of their ability to support classroom management activities made up 30.2% of all descriptions (N=60). This description was the most frequently cited across all description codes. As argued in later sections of this chapter, given the overall number of function codes identified across CHE texts along with the number of those codes comprising the description of "course management," LMSs were predominantly described as a tool supporting students and instructors manage course materials.

Integration. While "course management" made up a significant proportion of descriptions, so too, did the description of "integration." As a description, integration was the second most frequently occurring and was named in 27.1% of texts (N=54). Integration as a function was both explicit and implicit. When explicitly stated, the ways in which LMSs allowed students and instructors to incorporate outside online tools or IT services on campus, such as the library, were highlighted. Other explicit statements included the ability of some LMSs to support the development of tools within the system. More implicitly, integration denoted the ways in which the LMS was basic infrastructure for universities and largely taken for granted by university administrators, instructors, and students in supporting their use of various technologies on campus. As a code, "integration," captures a somewhat abstract component of LMSs, as infrastructure for integrating other information technologies. This code demonstrates that LMSs provided an infrastructure that instructors and university administrators could leverage in deploying new technologies.

Communication. LMSs were described in terms of their ability to support communication between and among instructors and students in 9% of texts (N=18). In 2009, under the topic of "distance learning," the ways LMSs supported communication was implied in the following way:

> A student who sits in the back and does not say a word in a face-to-face classroom may eagerly participate in a Blackboard or Moodle discussion. For that type of student, taking an online course facilitates the exchange of ideas and his learning of the course material. (C202, 2009)

Compared to the function-descriptions of "course management" and "integration," "communication" was the least frequently occurring. However, as compared to other

codes, such as those classified under "learning environments," the number of "communication" codes is not insignificant.

As the above overview demonstrates, LMSs were most frequently described in terms of their functions, and that these functions highlighted very pragmatic needs. Combined, the descriptions of "course management" and "integration" support an understanding for the ways in which LMSs were described as tools that could help instructors and students in managing the day-to-day realities of classroom life along with, indirectly, universities as a whole adapting to a changing technological landscape by providing a ready infrastructure for adding new information technologies.

Problems as Descriptions for Learning Management Systems

LMSs were also described in line with specific problems associated with their design and use. Under this category, 24% of texts described LMSs through the lens of their shortcomings. The most frequently noted problem was one of design (N=28, 14.1%). LMSs, under this code, were described as not supporting functions that instructors and students wanted. These systems were also described as highly dependent on instructors' use (N=10, 5.4%). Lastly, 4.5% (N=9) of texts described LMSs as costly technologies.

Poorly Designed. LMSs were described as poorly designed systems throughout their diffusion, and 14.1% (N=28) of CHE texts highlighted flaws in LMS design. However, well over half of the texts that described LMSs as poorly designed occurred between 2005 and 2010. For example, more interactive features of LMSs, such as discussion tools, were described as difficult to use. More generally, design problems

included the ways in which LMSs provided a general set of tools that could not be easily modified by users.

Dependent on Instructors' Use. In a limited number of texts (N=10, 5.4%), LMSs were described as dependent on instructors' use. This description contrasts somewhat with those that referred to LMSs as poorly designed. For this code, the problem that was highlighted was not with LMS, itself, but how instructors chose to deploy these tools. These descriptions evidenced frustration on the part of reformers and students in how instructors deployed these systems in university classrooms.

Costly Technology. A final way in which LMSs were described in terms of problems involved the shifting, and often, high costs of these systems (N=9, 4.5%). From 2001 onward, the cost of LMSs was used as a way to frame these systems. The increasing cost of LMSs, to many commentators, was inappropriate and inadequately justified. The cost of LMSs was questioned all the more as technology budgets across higher education institutions shrank. One way that some universities responded to rising costs from outside vendors was to build their own system. This make-or-buy decision resurfaced in discussions of open source technologies. Proponents of open source software argued that it was more cost effective and could help in controlling the costs of LMSs.

Descriptions related to problems associated with LMSs comprised 24% of all description-codes. The preponderance of these codes, both in terms of their frequency and their consistency over time, signals that there was a regular undercurrent of discontent related to LMSs. This discontent also suggests that despite the pragmatic needs that were being met by these tools, meeting these needs did not satisfy all users.

Justifications Ascribed to Learning Management Systems

Along with the above descriptions, LMSs were justified in terms of their adoption and their continued use along multiple dimensions. Across all CHE texts, 123 provided at least one justification, with some texts stating multiple justifications. In total, 184 justifications were identified. These individual justifications were coded into the following categories: (1) adapting to a changing technological landscape; (2) adapting to changes in higher education; (3) promoting technology innovation; (4) increasing efficiencies; (5) change pedagogy; and (6) ease of use. Table 4 presents the frequency and percent of CHE texts with each justification code. Overall, LMSs were largely justified in relation to adapting to a changing environment, whether technological or general issues in higher education. Combined, the theme of adapting to an external environment comprised 54.4% of all justifications. Below, the six justifications that were identified are described in further detail.

Table 4. Frequency of Justification Codes

Justification	Frequency	Percent with Justification Code	Percent of All CHE Texts
Adapt to tech. landscape	73	39.7	31.5
Adapt to changes in higher ed.	27	14.7	11.6
Promote technology innovation	25	13.6	10.8
Increased efficiencies	24	13.0	10.3
Change pedagogy/learning	19	10.3	8.2
Ease of use	16	8.7	6.9

Adapt to a Changing Technological Landscape. The justification of adapting to a changing technological landscape occurred across 39.7% (N=73) of all CHE texts that

provided a justification. This code emerged in relation to the ways LMSs supported universities integrate or make sense of new technologies. To be coded as a justification in relation to a changing technological landscape, the implication of a CHE reporter or commentator was that LMSs could support universities in responding to these changes. This code was closely related to the "integration" description-code. For the "integration" code, LMSs were described as a system for integrating information technologies. As a justification, some benefit to universities or individuals was implied.

Adapt to Changes in Higher Education. The code, "adapt to changes in higher education" occurred in 27 CHE texts (14.7%). Changes in higher education often centered on university finances and the potentially disruptive role of online learning opportunities. The role of online learning opportunities made up a large proportion of the 27 CHE texts with this code. Online learning, much like the Internet, was a dramatic shift occurring in the external environment at this time. LMSs played a similar role related to online learning that they did for the Internet: they provided universities with a concrete way to respond to these pressures.

Promoting Technology Innovation. LMSs were cited as promoting innovation on college campuses in 25 texts (13.6%). Promoting innovation was mentioned, for example, as arising from standardization among LMS providers. LMSs were adopted on many campuses and standardization among LMS providers supported universities incorporate new, different kinds of technologies. Early justifications around promoting innovation were more focused on LMSs, alone, whereby adopting an LMS would lead instructors to use more technology in their courses. Later justifications addressed how

LMSs could serve as a way to integrate newer products and services across an entire university.

Increasing efficiencies. For 24 texts (13%), LMSs were justified in terms of increasing efficiencies for instructors. LMSs increased efficiencies by supporting instructors in managing course materials and communicating with students. Therefore, by purchasing an LMS, it was implied that instructors would experience some gains in, for example, the amount of time that they could spend with students. In some cases, this implication had a more negative connotation. Instructors, it was implied, *only* experience efficiency gains as opposed to more revolutionary changes to how he or she teaches. However, these cases were limited, and most comments addressing efficiencies cited the positive ways in which using an LMS could make aspects of instructors' lives easier.

Change pedagogy. A regular justification for a variety of learning technologies is that they will change classroom instruction in some way (Zemsky & Massy, 2004). For LMSs, the idea that LMSs would accomplish this totaled 10.9% of all justifications (N=20). The spread of LMSs, by and large was accompanied by somewhat more measured rhetoric than the rhetoric accompanying computers and the Internet (Cuban, 2001). For example, for the introduction of the Open Knowledge Initiative, an initiative developed to provide common standards among LMS providers, was justified in the following way: "The resulting product will offer a variety of software modules that will function together to help professors teach online courses or enhance their classroom teaching" (C33). These types of justifications are a far cry from those made by commentators, such as Christensen et al. (2009) who argue for nothing short of the reinvention of higher education due to online technologies. When the rhetoric was high, it

was in relation to other innovations, such as the Internet or online learning, and not in relation to LMSs *per se*.

Ease of use. LMSs, from the outset, were framed as easy-to-use systems. In 1997, WebCT was introduced in the following way: "The set of programs, called WebCT (for 'Web Course Tools'), lets instructors design online courses through a series of simple forms accessible via the Web" (C4). Across texts that provided a justification, 8.7% identified ease of use (N=16). Being easy to use, much like increasing efficiencies, had both positive and negative connotations. In a few texts, the popularity of LMSs was disparaged because they were easy to use, but by and large, ease of use was a positive attribute and a supporting justification for these systems.

The most prominent justifications were those related to helping universities adapt to changing environmental conditions. While not stated explicitly, the implication for texts coded in terms of "adapting to a changing technological landscape" and "adapting to changes in higher education" is as follows: there are numerous technologies on the horizon and LMSs can support the integration of these technologies or provide a concrete way to bring these technologies into classrooms. Combined, the descriptions and justifications ascribed to LMSs provided powerful frames that helped universities navigate complicated institutional pressures. Given the concentration of the dominant descriptions and justifications highlighted above, LMSs gained legitimacy over time as these descriptions and justifications coalesced.

Summary

Several patterns emerged in the ways LMSs were described and justified. These patterns provide an initial way to identify how LMSs gained legitimacy. The first pattern involves the multiple topics under which LMSs were discussed. Across all CHE texts, LMSs were, at a minimum, mentioned in texts whose topics included distance learning, new technologies, the industry of LMSs, technology use in higher education, and general issues in higher education. This diversity in topics signals that LMSs touched multiple aspects of university activity and increasingly gained legitimacy across the organizational field of higher education. Over the 232 CHE texts in which LMSs were discussed, LMSs were described and justified in the following ways. Most frequently, these systems were described as a tool for supporting users in managing course materials (30.2%). LMSs were also frequently described as tools to support the integration of other technologies in and through the LMS (27.1%). These two descriptions, combined, represented 57.3% of all descriptions. In a similar way, two justifications made up a large proportion of overall justifications ascribed to LMSs in CHE texts. LMSs, for example, were justified in relation to their ability to support universities in adapting to multiple external pressures. Adapting to external pressures surfaced in the ways LMSs were discussed in relation to multiple developing technologies with the implication that LMSs could help universities in meeting the demands of integrating these new technologies. A second external pressure included general changes occurring in higher education during this time, including the growth of online learning opportunities. Adapting to these pressures, combined, made up 43.1% of all justifications.

Discussion

The first part of this chapter provided a chronological analysis of CHE texts and argued that LMSs gained legitimacy as an organizational response to multiple external pressures over a 16-year period. Multiple innovations, such as the Internet, online learning, and open source technologies, provided pressures to which universities were impelled to respond. Universities' created multiple responses to these general innovations; yet, LMSs remained one of the few consistent responses. The second part of this chapter presented the full range of descriptions and justifications ascribed to LMSs between 1995 and 2011. LMSs were regularly described as a collection of tools for supporting instructors manage course materials and grades. The adoption and continued use of these systems was justified most frequently in terms of their role in helping universities adapt to a changing technological landscape. The consistency of these descriptions and justifications, along with evidence from the chronological narrative, demonstrates that LMSs rapidly gained legitimacy in the organizational field of higher education as responses to multiple external pressures, which supported their adoption and continued use across colleges and universities.

The purpose of the above analyses was to examine a possible set of mechanisms that may have supported the diffusion of LMSs. As argued in prior chapters, no studies of the diffusion of LMSs specify why these systems are used on over 90% of colleges and universities in the United States. To address this gap, insights from neoinstitutionalism (Scott, 2008) provided a way to understand how and why LMSs diffused to the degree that they did. Based on the above analyses, universities were responding to a changing technological landscape, whereby numerous technologies were being developed outside

of the university and being appropriated into multiple aspects of everyday life. As these new technologies flourished, multiple commentators pressed universities to find ways to integrate these technologies. The ways in which universities were to actually deploy these technologies on their campuses, especially inside of classrooms, was far from obvious. One of the early ideas for integrating the Internet into instruction was to post course materials online. Along with putting course materials online, there were also many new sources of information available on the Web that could be used by students and instructors. The image of online course materials, therefore, represented an early, concrete way in which the Internet could find its way into college classrooms. LMSs, as the early press releases on these systems indicated, provided a way for universities to accomplish this task. As individuals within universities described and justified the adoption of LMSs as systems that could help instructors manage course materials, their legitimacy increased. As their legitimacy increased, so too did their diffusion.

LMSs, in many ways, benefited from being a ready technology for universities to adopt in line with the many calls for universities to include more technology in the classroom. Favlo (2007), for example, argues that given the Internet's rise, LMSs provided a way to bring more users to online environments because these systems automated "the administration and facilitation of online interactions and distribution of learning materials" (p. 40). It is conceivable, however, that any number of technologies developed between 1995 and 2011 could have provided universities and instructors with concrete ways of integrating the Internet into instruction. Yet, few of these possible technologies, such as Blogs and Wikis, reached a level of scale on par with LMSs. One plausible explanation, based on the above analyses, is that these systems were not

legitimated as a complete response to multiple pressures in the ways LMSs were. What is interesting about Blogs and Wikis is that they represent tools that were later integrated into LMSs. For universities, therefore, they could continue using their LMS, and in later years, take advantage of new features—all without having to purchase a new system.

The role of rhetoric in the early stages of diffusion is one of "sharpening beliefs that the new practices solve recurring practical problems" (Green, 2004, p. 658). As Abrahamson and Fairchild (1999) observe, emotionally charged and unreasoned discourse characterizes the rise of an innovation and qualified, reasoned discourse characterizes its downswing. In his analysis of the adoption of radio, television, and computers in K-12 schools, Cuban (1986) observes, "Claims predicting extraordinary changes in teacher practice and student learning, mixed with promotional tactics, dominated the literature in the initial wave of enthusiasm for each new technology" (p. 4). For LMSs, this highly pitched rhetoric common to other technologies largely did not occur. Instead, much of the inflated rhetoric revolved around problems for which LMSs were plausible solutions, such as the growth of online learning opportunities for students. The Internet, online learning, and open source technologies were the focus of highly pitched rhetoric; LMSs, on the other hand, were a simple strategy for universities to deploy in response to the pressures implied by this rhetoric.

The above analyses demonstrate how LMSs may have gained legitimacy, which serves as a plausible mechanism for explaining their diffusion and continued use. As universities felt pressures to integrate more technology, university administrators purchased systems that provided concrete uses for advancing technologies in classrooms. As more and more commentators cited the ways in which LMSs could help in managing

course materials and integrate advancing technologies, these systems developed into a legitimate innovation to adopt. Therefore, as multiple external pressures mounted, LMSs provided an early response that was viewed by other universities; social consensus eventually emerged around what LMSs were and how they could support universities.

Beyond providing a set of mechanisms for how and why LMSs diffused to the degree they did, however, the above analyses speak to a more general set of issues facing educational organizations outside of the hype and heightened rhetoric accompanying the development of the Internet. These issues include how PK-12 schools and universities negotiate external pressures. Given the structure of higher education, individual universities are largely responsible for making sense of these pressures and enacting responses. When the quality of teaching and learning is the focus of these pressures, one response is to purchase an instructional innovation that can be adopted to enhance current practices: nebulous external pressures become more concrete in and through the purchase of an instructional innovation (Spillane, Reiser, & Reimer, 2002). The legitimacy of the innovation as it is adopted can increase as adopters describe and justify their efforts. This process, therefore, has important implications for understanding how schools and universities translate external pressures into concrete organizational changes.

Relationship between Diffusion and Implementation

The above analysis demonstrates that LMSs gained legitimacy based on two factors: (1) they were described in relatively concrete terms, as tools for facilitating the management of course materials, and (2) they were justified in line with their ability to help universities adapt to a changing technological landscape. LMSs, therefore, created

benefits for important constituencies within universities, university administrators and academic committees. These constituencies are responsible for securing resources and managing relationships with external organizations. However, given the structure of most universities, instructors often have a great deal of autonomy in deciding whether to adopt an innovation purchased by an administrator or committee. Therefore, there is often slack in the system between the decisions of administrators and the actions taken by those carrying out the work of the organization, for example, university faculty. This slack in the organization between one organizational unit's decision and another's response is characterized by Weick (1976) as variation in "coupling." Coupling categorizes the effect of one unit's actions on anther's in terms of two outcomes, distinctiveness and responsiveness (Orton & Weick, 1990). If, for example, an academic administrator purchases an instructional innovation and an instructor uses that innovation as directed (low distinctiveness) and in a relatively short amount of time (high responsiveness), then that decision and subsequent response is tightly coupled. On he other hand, if a response is highly distinctive with limited responsiveness, then the response is de-coupled. Loose coupling captures how, across time, decisions and responses between organizational units vary between tight coupling and de-coupling. Schools and universities are regularly cited as loosely coupled organizations (Bidwell, 1965, 2001; Lortie, 1975), especially when decisions in one organizational unit are directed at affecting the ways in which instructors interact with students.

The following chapters outline the ways in which I examined one university's use of an LMS. The preceding chapters on the diffusion of LMSs treated individual universities in a rather generic way, as members of an organizational field in which an

innovation diffused. There is a certain tension, therefore, between the field-level analysis of diffusion and the organizational level of analysis that follows. This tension is most pronounced in understanding the relationship between an innovation's diffusion and implementation, and in particular, in relation to predicting the ways in which instructors may use these tools. Based on the above discussion of coupling, there are some generic predictions that can be made related to the way in which the University of Michigan (U-M)—the university studied in subsequent chapters—deployed its LMS.

If, as Orton and Weick (1989) argue, there are possible ranges in distinctiveness and responsiveness between a decision and a response, and universities are generally characterized as loosely coupled where distinctiveness and responsive vary a great deal, then the following patterns in LMS use may surface at U-M: there will be highly variable patterns in how instructors use these systems and some instructors will be highly responsive, i.e., early users of the LMS, and others not. Based on the data and methods used to examine LMS use at U-M, the distinctiveness of instructors' use of these systems can be evaluated with a great deal of accuracy in that the primary objects of measurement include data tracking users' actual interactions with they system. The responsiveness of instructors cannot be assessed with the same accuracy given the window in which the data was collected. Data tracking users' actual interactions could only be downloaded for the 2007 through 2010 academic years. The current system was deployed at U-M in 2005, with earlier systems dating back to 2001. Despite limitations around assessing responsiveness, the prediction that instructors will be highly distinctive in their use can be examined.

The following three chapters drill down into university classrooms to explore how these systems were actually used by instructors and students. Chapter 5 provides an overview of research documenting the uses of LMSs. Chapter 6 outlines methods for analyzing data that tracked users' actual interactions with an LMS. These data and analyses provide one of the first assessments of instructors' use of these systems at the scale of an entire university extending over multiple years. Chapter 7 presents results on how one LMS was actually used by instructors. These results compliment the previous chapters' depictions of mechanisms supporting LMS diffusion: because LMSs succeeded where many other technologies did not, in terms of their wide scale diffusion, an important component of understanding their ultimate "success" involves understanding how these systems were actually being put to use by instructors.

CHAPTER 5: OVERVIEW OF IMPLEMENTATION

Learning management systems (LMS) are a technology that diffused widely throughout higher education. The numbers are impressive. Over 90% of colleges and universities in the United States deploy an LMS on their campus (Smith & Caruso, 2010). These figures, however, do not attend to the ways in which LMSs have been implemented in university classrooms. LMSs are the focus of numerous studies, and one of the key findings shared across multiple analyses is that these systems have not dramatically changed the ways instructors organize their courses. Yet, despite the multiple studies that explore LMS use, few do so with large numbers of instructors or measure actual use of these systems. In this chapter, I describe prior research on LMSs and demonstrate the importance of grounding observations in data that tracks users' actual interactions with these systems.

The many studies describing how instructors and students use LMS tools converge on one overarching pattern: instructors use LMS tools that help in managing course materials and do not, on average, use more interactive tools on their course sites (e.g., Lonn & Teasley, 2009). The multiple studies that support this pattern, however, often do not assess how LMSs are actually used by instructors. This chapter sets up my argument for the importance of using "system log data"—data that tracks users' actual interactions with an LMS—to measure the ways in which these systems are used in

classrooms. Chapter 6 describes the ways in which I downloaded and analyzed system log data for approximately 19,000 course sites at the University of Michigan. Chapter 7 presents results related to these analyses and illustrates how using system log data can surface important sources of variation in how instructors deploy LMS tools in their classrooms.

In a recent EDUCAUSE survey, LMSs were the only technology used on a regular basis in classrooms. Clickers, E-Portfolios, and Blogs—along with six other technologies—were used by relatively few faculty and students as compared to LMSs, which were used by over 80% of those surveyed (Guidry & BrckaLorenz, 2010). These figures indicate that LMSs have found their ways into classrooms, and across multiple studies, LMSs, on average, are highly valued by instructors (Ansorge & Bendus, 2003; Dutton, Cheong, & Park, 2004a, 2004b; Hanson & Robson, 2004; Jones & Jones, 2005; Lonn & Teasley, 2009; Malikowski, 2008, 2010, 2010-2011; Malikowski, Thompson, & Theis, 2006, 2007; Morgan, 2003; Parker, Bianchi, & Cheah, 2008; West, Waddoups, & Graham, 2007; Woods, Baker, & Hopper, 2004). Across multiple studies, the primary reason instructors cited for using an LMS is that the LMS makes many elements of classroom life more efficient. These studies provide rationales for why instructors adopt LMSs but do not assess how LMSs are used. A lack of assessments for how instructors actually use LMS tools has led to several speculations. For example, faculty are regularly thought to start off using the LMS by deploying certain "low-level" features, such as content management tools, and gradually come to use more interactive features (Dutton, et al., 2004a; Malikowski, et al., 2006; Morgan, 2003; K. Oliver & Moore, 2008;

Papastergiou, 2006; West, et al., 2007). To move beyond speculation, however, researchers need to develop depictions for how instructors actually use these systems.

Prior research draws on variety of constructs to explain LMS use, such as attitudes (Adams, 2002; Nicolle & Lou, 2008), perceptions of value and usefulness (M. Hall & Elliott, 2003), and pedagogical beliefs (Bain & McNaught, 2006; Ertmer, 1999, 2005; Ertmer, Gopalakrishnan, & Ross, 2001). Along with these individual constructs, researchers of LMS use draw on full-fledged models that outline stages instructors are thought to progress through in order to effectively implement LMSs (Georgouli, Skalkidis, & Guerreiro, 2008; Holland, 2001; Howland & Wedman, 2004). These models are often derived from more recognizable ones, such as Rogers's (2003) adoption-decision framework, Hall and Hord's (1987) Concerns-Based Adoption model, and Davis's Technology Acceptance model (1989). For example, Kilmon and Fagan (2007) and West et al. (2007) examine LMS use from the perspective of Roger's adoption-decision framework. Using this framework, West et al. (2007) observe that it is important for instructors to experiment with the LMS and that this experimentation process may lead to instructors adopting more tools. Also deploying Rogers's framework, Bennett and Bennett (2003) observe the importance of professional training in influencing instructors' positive perceptions of LMSs. Rogers's framework was used to surface the following dynamics at one university:

> [T]echnology adoption has less to do with academic teachers' technology skills and their preference to use technology and more to do with the difference in their motivations, approaches to change, and to their learning and applying of new processes. It also found that top-down authority innovation directives and economic and political imperatives were practical and compelling technology-related reasons that motivated study participants to adopt web-based learning and teaching approaches…. Many teaching academics' adoption reasons were not just related to improving learning but were stimulated by the politics of the context

> such as top-down authority directive, funding grants, and faculty politics. Institutional context and procedures, faculty or department climate and ethos, and initiatives and incentives aimed at improving productivity played a commanding role in adoption decisions. (Samarawickrema & Stacey, 2007, p. 330)

Samarawickrema and Stacey, and others (e.g., Benson & Palaska, 2006), highlight the important role that organizational elements, such as authority relations, can play in the implementation of LMSs. Likewise, numerous studies use Davis's (1989) Technology Acceptance Model, and related versions, to describe instructors' (Sanchez-Franco, 2010; van Schaik, 2009; Wang & Wang, 2009) and students' use of LMS tools (Abdall, 2007; Ngai, Poon, & Chan, 2007; Pan, Gunter, Sivo, & Cornell, 2005). These studies consistently signal that users' perceptions of usefulness and perceptions of ease of use, are correlated, on average, with increased adoption (Parker, et al., 2008; Steel, 2009). However, students' perceptions of LMSs are often collected within courses for which an instructor has already integrated the LMS into his or her instruction thereby creating a false sense of an adoption-decision for students (Elicker, O'Malley, & Williams, 2008; Korchmaros & Gump, 2009; Liaw, 2008). In total, these studies demonstrate that without accurate illustrations for how instructors and students actually use these systems, many of these constructs, models, and observations remain speculative.

Other factors thought to affect LMS adoption include the general design of LMSs, which is argued to lead instructors to adopt LMS tools in ways that fit within their traditional, preexisting instructional practices (Coates, James, & Baldwin, 2005; Klein & Sorra, 1996; Koszalka & Ganesan, 2004). As Lane (2009) observes, LMSs were designed as a flexible technology to support instructors across content areas, and this flexibility, along with their "default" settings, promote uses that do not lead instructors to adopt more interactive teaching and learning tools. Conversely, some have argued that these

systems support more progressive pedagogical styles and can be a catalyst for instructors to reimagine their instructional practices (e.g., Papastergiou, 2006). While the design of the LMS can affect what tools instructors adopt, so too is the context in which instructors teach, such as his or her academic unit (Lin & Ha, 2009; Lin, Singer, & Ha, 2010; Malikowski, et al., 2006) along with the size of the class and the level of the course (Malikowski, 2008).

Across the multiple studies and theoretical perspectives, the ways in which instructors use LMS tools in their courses is a topic of increased speculation but rarely the object of direct measurement. Some studies, however, have attempted to describe the ways in which individuals actually use LMS tools. However, even for studies that attempt to move beyond self-report measures, alone, they are often conducted on limited scales and use statistical techniques that do not allow for the identification of important sources of variation in LMS use.

Measuring Learning Management System Use

A general critique related to many of the above studies is that they do not attend to the ways students and instructors actually use LMS tools. While measuring actual use of any instructional innovation can be difficult (Rowan, Camburn, & Correnti, 2004), what is unique about LMSs is that users' interactions with these systems are captured by the system, itself, providing the opportunity to accurately describe use. Despite the ability of many LMSs to capture users' interactions, a limited number of studies examine use of LMS tools drawing on these data.

One of the first and most comprehensive studies of actual LMS use is Morgan's (2003) assessment of the University of Wisconsin system. Using a combination of surveys, interviews, and system log data, Morgan (2003) documents how instructors typically adopt LMS tools to manage more mundane aspects of course activities, such as distributing materials and communicating with students. Factors influencing tool-use include recommendations from peers along with pressures from university administration. The strongest factor influencing adoption, as reported by instructors on a questionnaire, was that the LMS helped to solve a specific pedagogical problem. However, upon follow-up interviews, the pragmatic management of course materials appeared to be the reason undergirding the idea of a pedagogical problem. Building on the insights of Morgan (2003), Lonn and Teasley (2009) used system log data and a questionnaire to examine students and instructors' actual use of an LMS. Overall, according to Lonn and Teasley, instructors and students value and use the LMS more for "efficient communication" over enhancing "teaching and learning." The authors conclude their study with the following point:

> In recent years, these types of systems have switched their monikers from Course Management Systems to Learning Management Systems. Embedded in this change is the notion that learning involves more than providing course content efficiently…. [B]oth instructors and students agree that information technologies improve learning, students do not agree as strongly as instructors that such technologies do improve instruction. These ratings suggest that students, in particular, may be responding not to whether these tools are used, but rather how they are used. (p. 693)

Lonn, Teasley, and Krumm (2011) expand upon these observations and address the ways in which beliefs related to uses for the LMS can translate into different use-patterns among instructors. Different use-patterns can also be influenced by university context (e.g., residential versus commuter and research versus comprehensive universities);

perceptions of value for specific interactions among students, instructors, and content supported by an LMS; and demographic characteristics. Multiple researchers document similar patterns between interactive and managerial uses for an LMS (Dutton, et al., 2004a, 2004b; Klobas & McGill, 2010). For example, Nijhuis and Collis (2003) examined the amount of time instructors spend on an LMS. The most frequently used tools across 64 courses for which system logs data was collected were email, course announcements, and web links—all of which demonstrate the degree to which course instructors use managerial tools over those that may support more interaction among instructors, students, and content.

Malikowski (2008) observes that the most frequently used categories of LMS tools include tools that "transmit documents to students, communicate asynchronously, quiz students, use a drop box to exchange files with students, and survey students" (p. 81). Building off of his own prior work, Malikowski continues, "CMSs are primarily used to transmit information to students, such as a syllabus or assignment description. Interactive CMS features are used less than half as often as features for transmitting information" (p. 82). In a later analysis, Malikowski (2010-2011) presents a longitudinal depiction of tools used by instructors. He identifies what may be termed a "stable state" of LMS use, which is largely comprised of instructors' use of only materials management tools with little evidence of experimentation related to more interactive tools (K. Oliver, 2001). "The most prominent characteristic of this stable state is that CMSs are primarily used for transmitting information to students and occasionally used for student interaction, such as interacting with other students, professors, or interactive quizzes" (Malikowski, 2010-2011, p. 78). While these studies represent important models for

assessing actual use of LMSs, few studies, with the exception of Morgan (2003), Lonn and Teasley (2009), and Lonn, Teasley and Krumm (2011) examine actual use at scales larger than 100 courses or use statistical techniques that align use-patterns with psychological constructs, such as beliefs and attitudes, that are thought by many to influence adoption. To overcome several of these shortcomings, methods outlined in Chapter 6 describe how I examine LMS use at the scale of an entire university and align beliefs with use-patterns. While multiple factors, such as context and psychological constructs, have been identified as influencing use of LMSs, these factors have not been examined simultaneously, with large numbers of instructors, over time (Malikowski, 2008; 2010-2011). The specific ways in which these factors are explored are described in detail in Chapter 6.

Summary

Because LMSs represent one of the few learning technologies to diffuse widely, the ways in which they are actually used in classrooms represents an important area of research. In general, prior LMS research has examined the use of these systems drawing on self-report measures, alone, with less than representative samples of instructors. Moreover, many studies simply examine users' perceptions of LMS tools and, therefore, do not identify relationships between an instructor's self-reported beliefs and actual use of LMS tools (Chanchary, Haque, & Khalid, 2008; Yohon, Zimmerman, & Keeler, 2004). Zhao et al. (2002) observe that most studies of technology adoption are at a basic level simply looking for,

> correlates among the many variable influencing teachers' use of technology for professional and personal reasons. These types of studies tend to neglect the

> messy process through which teachers struggle to negotiate a foreign and potentially disruptive innovation into their familiar environments. (p. 483)

Zhao and Frank (2003) and others (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004), in response to the abundant lists of factors affecting technology use, describe a need for higher levels of ecological validity related to studies of technology use. One way to achieve higher levels of ecological validity is to develop accurate depictions of use, over time, and with large numbers of instructors. Therefore, to overcome several of the limitations associated with prior research on the use of LMSs, the following chapter describes methods for analyzing LMS use at the scale of an entire university using data tracking users' actual interactions with an LMS. These data and methods are organized around research questions aimed at unpacking dominant patterns in LMS use along with course-specific and instructor-specific factors that may explain these patterns. The following chapter on data and methods provides a comprehensive and longitudinal assessment of actual use of an LMS, which represents one of the first efforts to describe the use of any learning technology at this scale.

CHAPTER 6: IMPLEMENTATION DATA AND METHODS

Because learning management systems (LMS) represent a learning technology that achieved wide scale diffusion, the ways in which they are used in university classrooms represents an important line of inquiry. Prior technologies that achieved similar levels of diffusion, such as computers in K-12 classrooms, have largely been documented as not being used. LMSs appear to be different because some LMS tools are regularly used by large numbers of instructors (Smith & Caruso, 2010). In the previous chapter, LMS use was seen as widely studied but at limited levels of analysis with data that does not track actual use of these systems. For this study, LMS use is examined across 19,091 course sites at the University of Michigan (U-M) using system log data, which tracks users' actual interactions with an LMS. The following research questions guided data collection and analyses:

2. What are the dominant patterns in LMS use by instructors across one university?
    a. What course-specific factors help to explain instructors' use of an LMS?
    b. What instructor-specific factors help to explain instructors' use of an LMS?
    c. How do instructors' use of the LMS change over time?

To describe LMS use at U-M, system log data along with questionnaires administered annually to instructors and students were collected over six semesters, from 2007 to 2010. Using data tracking instructors and students' interactions with the LMS, a metric referred to as a course complexity-score (C-S) was developed to capture the number and

types of tools used on a course site. The C-S served as a dependent variable across several regression models that provided comprehensive frameworks for examining the research questions outlined above.

U-M is a selective, large, and research-intensive university located in the Great Lakes region of the United States. U-M was selected for this study because it (1) provided a high degree of access to system log data and questionnaires, (2) is a mature user of its campus LMS and is a recognized leader in the development of learning technologies for colleges and universities, and (3) is a large campus that enrolls approximately 26,000 undergraduate students and 15,000 graduate students and employs approximately 5,700 tenure and non-tenure track faculty members. For the above reason and because of the variety of academic units located within U-M, this university provided a large and diverse range of instructors and courses with which to explore depth of LMS implementation at the scale of an entire university.

U-M has a long history in the development of learning technologies for higher education. The first LMS used on campus was developed in 1997 through what was then called the Office of Instructional Technology in partnership with the Schools of Business and Nursing. The system was developed using Lotus Domino software and was envisioned to support the delivery of course materials online. Resources at the university that were supporting the development of web-based collaboration software for space physics researchers were later repurposed to support the development of a more robust LMS. The retooled collaboration software was becoming a popular course supplement with over 10,000 students using an early version of the software in 1999. The popularity of LMSs throughout higher education was growing in the early 2000s, and a group of

universities formed a collaboration to develop their own LMS under the name of the Sakai Foundation. U-M was one of the primary partners in this effort and in 2005 launched its instantiation of Sakai, called "CTools," with over 25,000 users in the first semester. U-M's long history of LMS use presents a unique opportunity to examine the implementation of LMSs. Data tracking instructors and students' interactions with CTools was collected and aggregated from 2007-2010. System log data collected over this time period provided an opportunity to examine the ways in which these systems were used in university classrooms and to speculate on their depth of implementation.

Table 5. Course Sites Created by Academic Unit and Semester

	Semester					
	Fall 2007	Winter 2008	Fall 2008	Winter 2009	Fall 2009	Winter 2010
Arch. & Urban Planning	55	59	52	65	82	69
Art and Design	41	32	44	46	67	53
Business	150	193	177	209	206	215
Dentistry	30	31	40	42	51	50
Education	69	60	75	71	89	66
Engineering	253	267	292	326	337	353
Information	47	37	54	48	68	42
Kinesiology	49	51	41	59	65	65
Law	95	97	108	127	119	130
LSA Humanities	845	780	906	883	1106	957
LSA Natural Science	188	249	329	332	418	369
LSA Social Science	496	476	571	524	700	656
Medicine	25	44	33	47	45	46
Music, Theatre, & Dance	68	78	80	86	119	104
Natural Resources & Env.	16	21	23	24	26	30
Nursing	64	61	67	69	79	87
Pharmacy	17	21	17	23	20	24
Public Health	84	89	90	106	109	116
Public Policy	25	25	29	28	32	35
Social Work	45	44	78	82	115	91
Total	2662	2715	3106	3197	3853	3558

Note: Total number of course sites (19,091)

There are 20 "academic units", i.e., schools, colleges, and programs, at U-M. According to the University Registrar, there are 24 units. These 24, however, were modified to make clearer distinctions among units and to aid in the interpretability of related results. For example, Dental Hygiene and Dentistry—identified as two separate units—were combined into a single unit, "Dentistry". "Officer Education Programs" and similar small-scale, non-degree granting units were removed due to limited numbers of course sites available for analysis within these units. The largest unit on campus—Literature, Sciences, and the Arts (LSA)—was broken out into three distinct units: LSA Humanities, LSA Natural Sciences, and LSA Social Sciences. After modifications, twenty distinct academic units were identified. These 20 academic units are listed in Table 5 along with counts for the number of LMS course sites created within each unit.

Overview of the Learning Management System at the University of Michigan

The LMS analyzed in this paper is based on the Sakai community-source architecture and is referred to at U-M as "CTools." CTools has functionality similar to that of other LMSs, such as Blackboard. While each LMS distinguishes itself in some way, there are multiple features available across all LMSs, such as asynchronous and synchronous messaging tools as well as course material distribution tools. Data from 14 LMS tools were examined in this study. Twenty-four tools are available within CTools, and from these, 14 tools were selected because they logged events that tracked users' interactions with the system.[3] The names of the 14 tools examined are provided in Table

[3] https://ctools.umich.edu/portal/site/!gateway/page/304e8306-ae9e-45cc-a56d-fa2f8bf234f8

6, along with a brief description of each tool's functionality. Table 7 presents the percent of course sites using a given tool.

Figure 2. Sample Screen Image from My Workspace

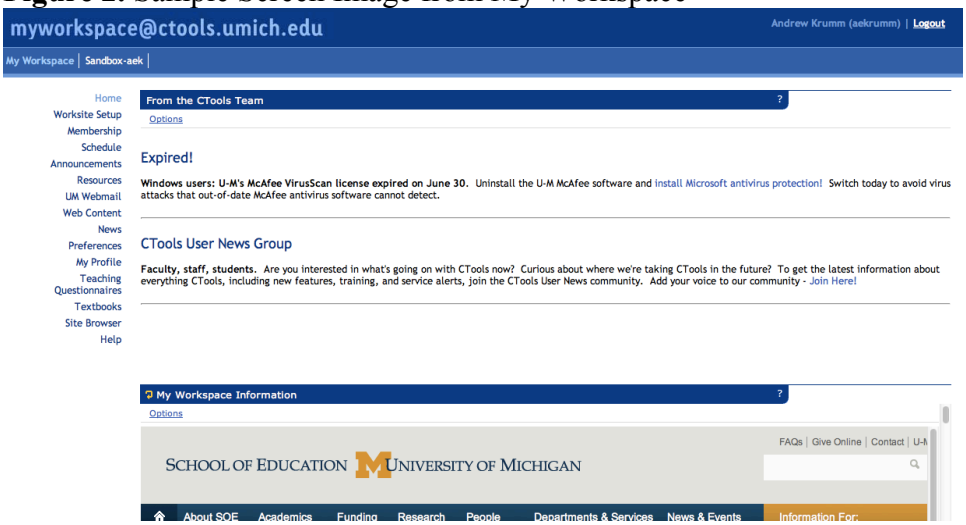


Figure 3. Sample Screen Image for Course Site Homepage

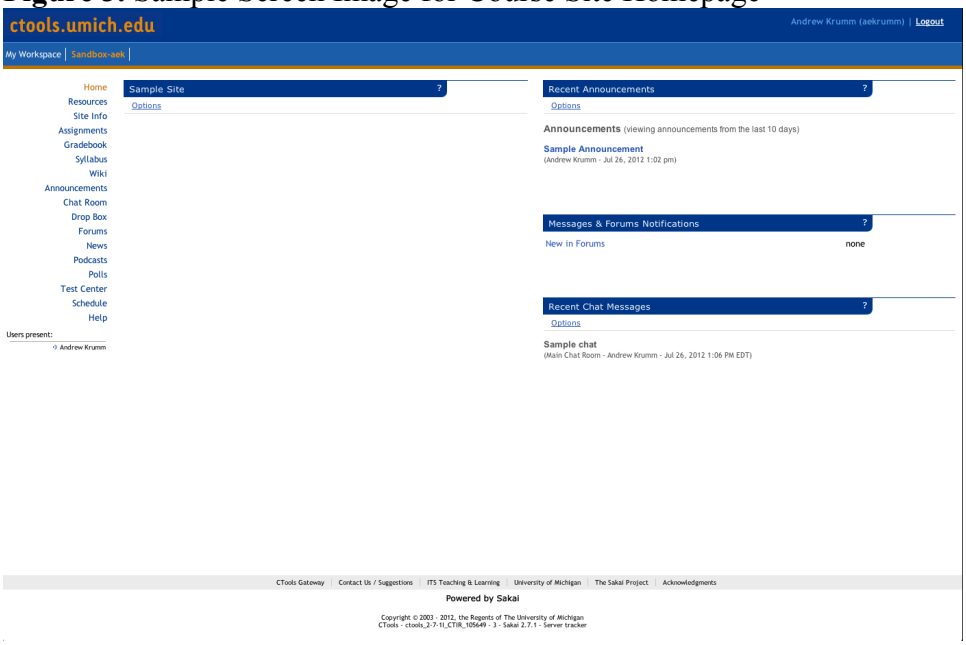


Figure 2 presents a screen image from the My Workspace page within CTools, which is the first page that a user sees after logging into the system. There are multiple links provided on the left-hand side of this page that allow a user to customize various aspects of My Workspace. A user accesses a course site by selecting a course's name from the navigation menu at the top of the screen. Once a user has selected a course, he or she is directed to that course's homepage, an example of which is displayed in Figure 3. On the left-hand side of a homepage a user can access an LMS tool. Brief descriptions for these tools are provided in Table 6. An instructor organizes a course site by selecting the tools to be displayed. In Figure 3, 14 tools populate the left-hand navigation area along with two other menus, Site Info and Help. Site Info is where users can manage LMS tools along with course participants, which can include students or other interested parties, such as an instructor's colleague or graduate student instructor. The homepage can be customized, and some tools, such as Announcements, post information directly to the homepage. Once a user selects a tool, he or she is taken to that tool's webpage. Figure 4 illustrates how the Assignments tool can appear to a user. This tool provides a structured way for instructors and students to exchange course assignments along with descriptions and grades associated with each assignment. As described in further detail below, each tool available on the LMS tracks users' interactions with the system to some degree. Fourteen tools were selected for analysis based on the detail with which users' interactions were tracked. For this study, a tool needed to be used on a course site to a minimal degree and not simply activated. This distinction is important because activating an LMS tool by adding it to the left-hand navigation area is different from actually using it.

In order for an event to be used as an indicator of a tool's use it needed to be consistent across multiple semesters as well as identify whether a user uploaded something to an LMS tool, downloaded something from a tool, or read something made available through a tool. Tool-use was then dichotomously scored as "used" or "not used" based on the number of counts for relevant events. Two thresholds for relevant events were developed. For low-event tools, such as Announcements, a course site needed to log 1 "new" event, which signaled that an announcement was posted to the course site. For high-event tools, such as Assignments, a course site needed to log 2 "submit" events, which signaled that two assignments were submitted to a course site. Relevant events were identified for each tool, and if a course site logged events greater than or equal to the thresholds established for those events, the tool was coded as "used". If a tool did not log enough counts for specific events it was "not used". In order for a course site to be included in the final dataset, it needed to meet the following criteria: (1) use 1 or more tools, (2) have fewer than 1,000 students or more than 3 students enrolled on the course site, and (3) have proper identification information, such as a course title and supervising academic unit. Across all six semesters, a total of 19,091 course sites met the above criteria.

Figure 4. Sample Screen Image for Assignments Tool

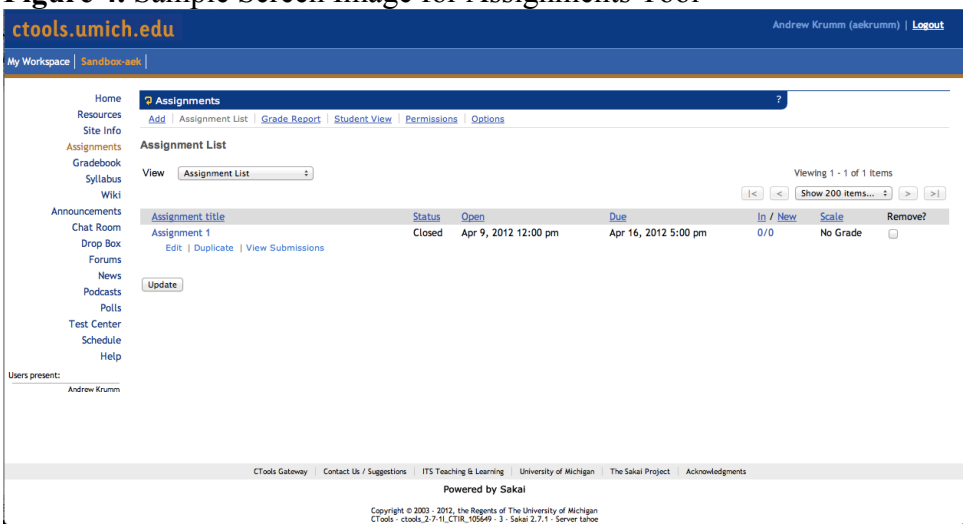


Table 6. Description of Learning Management System Tools and Functionality

Tool	Description
Announcements	Asynchronous messaging tool used to contact all members of a site
Assignments	Tool used to collect and distribute course assignments
Calendar	Shared course calendar/schedule
Chat	Synchronous messaging tool
Discussion	Threaded, asynchronous messaging tool
Drop Box	File exchange tool
Gradebook	Online grade book tool
Podcast	Provides access to a course's individual iTunesU page
News	RSS feed tool
Polls	Poll generation tool
Resources	Storage space for individual files and URLs
Syllabus	Location for course syllabus as a webpage or attached file
Test Center	Test generation tool
Wiki	Collaborative document tool

Note: Forums, Messages, and Message Center were all coded as "Discussion"

Table 7. Percent of Course Sites Using a Learning Management System Tool

Tool	Fall 2007	Winter 2008	Fall 2008	Winter 2009	Fall 2009	Winter 2010
Resources	86.4	88.7	87.3	88.6	89.7	91.1
Announcements	94.1	93.4	94.9	93.0	84.3	81.9
Syllabus	42.8	39.6	45.1	45.2	45.0	45.3
Drop Box	39.5	33.1	36.0	32.1	36.1	33.8
Assignments	28.3	26.0	28.3	29.3	24.3	26.7
Gradebook	--	13.5	18.1	19.2	20.7	21.7
Discussion	26.5	25.5	24.9	22.4	23.3	21.3
Chat	14.0	13.9	14.2	12.6	14.0	12.4
Calendar	16.7	12.4	14.6	12.1	11.4	9.9
Podcast	--	<0.1	7.7	8.6	8.5	6.8
News	9.8	8.6	6.6	4.6	4.5	3.3
Wiki	2.3	2.2	2.3	2.6	2.8	2.6
Polls	0.1	<0.1	1.4	1.8	3.1	2.5
Test Center	--	<0.1	0.9	1.9	2.4	2.4
N	2662	2715	3106	3197	3853	3558

Note: N=19,091

Questionnaire

Data from an annual questionnaire was used to identify how multiple instructor-specific factors were related to an instructor's use of the LMS (RQ#2b). Data from the questionnaire was used in a 3-level latent growth curve model (Raudenbush & Bryk, 2002), described in more detail below. The questionnaire was comprised of approximately 30 questions, with several questions providing multiple response items; in total, there were approximately 150 items covering three topics: (1) demographics, (2) perceived value of information technology (IT), and (3) perceived value of LMS tools and uses. The questionnaire was administered online and distributed to all faculty members at the end of each academic year.

Three questionnaires were administered in 2008, 2009, and 2010. The response rate for instructors for the 2008 questionnaire was 20% (N=7,341; n=1,504), 16% for

2009, (N=7,702; n=1,202), and 13% for 2010 (N=7,626; n=1,017). In total, 3,723 surveys were collected spanning the above three-year period. Of these 3,723 surveys, 2,767 unique instructors took the survey. Of these unique instructors, 2,009 took the survey one time, 560 took the survey two times, and 198 took the survey three times. Of the total number of instructors, 920 had an employment status of a graduate student instructor and were removed from regression analyses. Of the available 1,847 unique non-graduate student instructors, a further 553 were removed from analysis because they did not use the LMS or had course sites that were not used during the 2007-2008 or 2009-2010 academic years. These instructors, therefore, did not have data on the key dependent variable used in subsequent analyses. In total, questionnaire data from 1,294 instructors was used. These 1,294 instructors generated data for 8,922 course sites.

Fifteen items from the questionnaire were used. One item asked respondents to self-report the amount of IT that they used in their courses, another item asked instructors for the numbers of years they have taught in higher education, and the remaining 13 items elicited instructors' perceptions of value for specific uses of the LMS, such as, "Asking students to read and/or comment on each others' course-based work." These 13 items were grouped into broader classes of "interaction-types" using descriptions of online interactions from Bernard et al. (2009) and Moore (1989). Items were grouped under the following interaction-types: Learner-Learner (LL) interactions, Learner-Content (LC) interactions, or Learner-Instructor (LI) interactions. These interaction-type scores provided a parsimonious way to understand an instructor's perceptions of value for uses of the LMS. Because changes in beliefs can have an impact on the degree to which an instructor changes his or her practice, capturing an instructor's beliefs through the lens of

interaction-types provides a series of instructor-specific factors for examining the depth of LMS implementation (RQ#2b).

Using principal components analysis, single component scores were extracted for each interaction-type (see Table 8). For each interaction-type score, approximately half of all respondents had at least one item scored as "missing." Before the interaction-type scores were developed, stochastic regression imputation methods were employed to include those individuals who had one or more missing items (Little & Rubin, 1987). Using regression imputation models, each item used to make up an interaction-type score was regressed on the following variables: a dummy variable identifying whether an instructor was a faculty member or graduate student instructor; dummy variables indicating a respondent's self-reported expertise with computers (novice, advanced, or expert); a Likert-scale variable measuring the degree to which one values the campus LMS, a 5-level variable indicating the degree to which one uses general IT in their courses (none, limited, moderate, extensive, or exclusive); a 6-level variable indicating the number of years for which one has been an instructor (1 year or less, 2-5 years, 6-10 years, 11-20 years, 21-30 years, or more than 30 years); a 5-level variable identifying the number of courses for which an instructor self-reported having used the LMS (none, 1-2, 3-6, 7-10, or more than 10); as well as remaining LMS-use items making up an interaction-type score. Each respondent with a missing value was given an imputed value based on his or her outcomes from the appropriate regression model. A random component was then incorporated into each final imputed value, which created greater dispersion across the distribution of imputed values.

Table 8. Interaction-Type Component Score Statistics

	2008			2009			2010		
	Eigen.	%	Rel.	Eigen.	%	Rel.	Eigen.	%	Rel.
LL	2.13	53.3	.70	2.30	57.4	.75	2.28	56.9	.75
LC	2.39	47.9	.72	2.66	53.2	.77	2.39	47.9	.72
LI	2.66	53.3	.77	2.82	56.4	.79	2.80	55.9	.78

Note: Eigen. = Eigenvalue, % = Percent of variance explained, Rel. = Reliability

The Course Complexity-Score

To operationalize depth of LMS use, a single metric was developed referred to as the course complexity-score (C-S), which quantified both the number and types of tools activated on course site. To develop the C-S, system log data tracking actual use of the system was aggregated at the course level, i.e., activity for all members on a course site was summed to one value that illustrated total use of a tool for a site. This aggregation strategy provided a way to assess depth of LMS implementation across an entire university, extending over multiple semesters, in an efficient and manageable way. The C-S was produced using a 2-Parameter Item Response Theory (IRT) model (Embretson & Reise, 2000). A 2-Parameter IRT model was selected because these models incorporate a specific weighting, or discrimination parameter, for each tool, whereby two course sites that used the same number of tools, but different combinations of tools, received different C-Ss. To take advantage of this and other properties of IRT models (e.g., item and individual scores are on the same scale), LMS tool-use needed to be coded in dichotomous form as either “used” or “not-used.”

Statistical Models Using Course Complexity-Score

The structure of the final dataset necessitated the use of multiple statistical models, i.e., fixed-effects and latent trait growth models, to assess the primary research questions explored in this study. One challenge that the use of multiple models overcame involved the ways in which courses were nested within instructors who themselves were nested within academic units. Multiple instructors could teach a single course, and a large proportion of course sites had multiple individuals set as an "owner" or "instructor" for the course site. Multiple instances of the same course for multiple instructors created repeated measure for course-specific factors, such as the number of students enrolled on a course site. To avoid biased estimates related to these factors, course-specific factors were examined using a fixed-effects model for 19,091 course sites and instructor-specific factors were examined in a latent growth curve model (Raudenbush & Bryk, 2002). A limited sample of instructors (N=1,294) and course sites (N=8,922) were used based on whether an instructor completed a questionnaire between 2008 and 2010.

Fixed-Effects Model

The fixed-effects model assessed research question #2a, the effects of course-specific factors related to depth of LMS use. Factors included in this model are as follows: (1) the level of the course, (2) the number of students enrolled on a course site, (3) the academic unit for the course site, and (4) the semester during which the course site was active. These factors were selected to explain depth because they were embedded in system log data and provided a way to assess whether depth of implementation was affected by generic, easily observed differences among courses in that these differences

may signal possible differences in instructional practices across these factors. For example, graduate courses stereotypically imply a seminar style of instruction, whereas undergraduate courses can take on a variety of different styles based on the number of students enrolled in the course and the academic unit in which the course is housed.

The four course-specific factors of interest were modeled as follows: the level of the course was dummy coded for graduate and undergraduate level courses; the number of students on a course site were dummy coded into quartiles of 4-15 students, 16-23 students, 24-44 students, and greater than 45 students; academic units were dummy coded into 20 separate units; and the six semesters were dummy coded into time variables from Fall 2007 to Winter 2010. Interaction terms were also modeled for undergraduate courses and academic units as well as undergraduate courses and number of students. Table 9, above, provides frequency counts for the number of course sites across each categorical variable included in the above model as well as the means and standard deviations for C-Ss across each categorical variable.

Latent Growth Curve Model

The latent trait growth curve model assessed the effects of instructor-specific factors on depth of LMS use (RQ #2b) as well as how instructors modified their use of the LMS over time (RQ #2c). Instructor-specific factors that were included in the model are as follows: (1) interaction-type scores, described previously, (2) a measure of general IT use, (3) whether an instructor participated in a professional development workshop related to the LMS, and (4) the number of years for which an instructor has been an instructor in higher education. These instructor specific factors were selected to explain

depth of LMS implementation because beliefs are related to one' instructional practice and how much IT an instructor uses may signal underlying differences in instructional practices because instructors often need to restructure instructional practices in order to integrate technology. Whether an instruction has participated in an LMS related workshop may indicate that an instructor has received supports important to changing one's practice. The number of years for which one has been an instruction in higher education may indicate stereotypical difference in instructional styles and preferences to use IT among instructors who have taught for different numbers of years.

This model also assessed the level of change in an instructor's use of the LMS over time along with the impact of the four instructor-specific factors outlined above. A 3-level growth curve model was fit using HLM 6. The growth term in this model was constructed to understand changes across an instructor's subsequent uses of the system. It was ordered from 0 to 5, where 0 indicated the first semester that an instructor used the LMS and 5 indicated the sixth semester that an instructor used the LMS. Growth, therefore, was modeled as a function of average LMS use across semesters.

The data for this model was structured by nesting course sites within instructors and academic units. Thus, the C-S given to each course site was modeled at level-1 and instructor level covariates at level-2. Descriptive statistics for this model are presented in Table 10. For those who took the survey more than once, appropriate independent variables were combined and divided by the number times that he or she took the survey, producing an average score. For instructors who took the survey only once, no modification was made to their responses; 758 instructors were given an average score. Whether an instructor participated in an LMS related workshop was constructed by

compiling attendance lists for these workshops at U-M. Lists were aggregated from 2005 to 2010. In total, 218 sampled instructors participated in at least one workshop.

Table 9. Descriptive Statistics for Fixed-Effects Model

	N	%	C-S Mean	C-S SD
Level of Course				
Undergraduate	12,956	67.9	-.052	.700
Graduate^	6135	32.1	-.191	.691
Number of Students				
4-15 Students^	5075	26.6	-.245	.654
16-23 Students	4835	25.3	-.068	.701
24-44 Students	4493	23.5	-.038	.721
Greater than 45 Students	4688	24.6	-.022	.703
Semesters				
Fall 2007^	2662	13.9	-.092	.694
Winter 2008	2715	14.2	-.125	.668
Fall 2008	3106	16.3	-.028	.702
Winter 2009	3197	16.7	-.067	.692
Fall 2009	3853	20.2	-.114	.725
Winter 2010	3558	18.6	-.146	.699
Academic Unit				
Architecture & Urban Planning	382	2.0	-.321	.679
Art and Design	283	1.5	-.190	.688
Business	1150	6.0	-.106	.678
Dentistry	244	1.3	-.320	.743
Education	430	2.3	.176	.689
Engineering	1828	9.6	-.016	.729
Information	296	1.6	.175	.717
Kinesiology	330	1.7	-.258	.736
Law	676	3.5	-.608	.400
LSA Humanities^	5477	28.7	-.104	.681
LSA Natural Science	1885	9.9	-.169	.635
LSA Social Science	3423	17.9	-.001	.693
Medicine	240	1.3	-.215	.599
Music, Theatre & Dance	535	2.8	-.312	.698
Natural Resources & Environment	140	.7	-.161	.633
Nursing	427	2.2	.266	.803
Pharmacy	122	.6	.010	.661
Public Health	594	3.1	-.073	.668
Public Policy	174	.9	.048	.706
Social Work	455	2.4	-.042	.844

Note: ^=Reference category for fixed-effects models

Table 10. Latent Growth Curve Model Descriptive Statistics

	N	Mean	SD	Min.	Max.
Instructor level					
Use of IT	1294	2.93	.73	.00	5.00
L-L Interaction	1294	.04	.99	-3.87	2.25
L-C Interaction	1294	.03	1.03	-5.98	1.63
L-I Interaction	1294	-.02	1.02	-4.45	2.19
Attend Workshop	1294	.17		.00	1.00
<1 Years Teaching	1294	.08		.00	1.00
2-5 Years Teaching^	1294	.19		.00	1.00
6-10 Years Teaching	1294	.19		.00	1.00
11-20 Years Teaching	1294	.27		.00	1.00
21-30 Years Teaching	1294	.16		.00	1.00
>30 Years Teaching	1294	.11		.00	1.00

Note: ^ = Reference category for growth model

Summary

To describe how one LMS was used at U-M, system log data and specific items from an annual questionnaire were used to depict instructors' use of an LMS over a three-year period. System log data was dichotomously scored based on the tools activated on a course site and transformed into a metric referred to as a course complexity score (C-S). The C-S assessed the number and types of tools used on a course site and was modeled as a dependent variable in several multiple regression analyses. These regression models, along with IRT modeling techniques, assessed dominant patterns of LMS use at U-M (RQ #2). Fixed-effects and latent growth curve models assessed the effect of course- (RQ #2a) and instructor-specific (RQ #2b) factors, respectively, as well as how depth of implementation changed over time. The data and methods outlined in this chapter provide one of the first attempts to measure instructors' actual use of an LMS at the scale of an entire university. Because scale was an important component of these analyses—to determine differences between, for example, the ways in which academic units deploy

these systems—the C-S provided a parsimonious metric that also captured some degree of nuance in how instructors used these systems. Individual patterns of tools used on a course site, for example, were given unique C-S values, which provided greater dispersion among instructors using the same number of tools. Chapter 7 outlines results related to the analyses described in this chapter.

CHAPTER 7: IMPLEMENTATION RESULTS AND DISCUSSION

How LMSs are used in university classrooms is an important empirical question given that these systems represent one of the few technologies to have diffused widely. This chapter describes learning management system (LMS) use at the University of Michigan (U-M) in an effort to address an important gap in the extant literature on LMSs. This gap involves understanding how these systems are actually used by large numbers of instructors extending over multiple semesters. To bridge this gap, LMS use at U-M was captured by analyzing system log data that tracked users' actual interactions with the campus LMS. System log data were analyzed in line with beliefs and attitudes measured on an annual questionnaire administered over three academic years. Combining system log data with instructors' attitudes represents one of the first attempts to align beliefs and behaviors related to a learning technology at the scale of an entire university.

LMS use was operationalized in the form of a course complexity-score (C-S), which provides a single metric that quantifies the number and types of tools used on a course site. Descriptive analyses using the C-S helped to assess dominant patterns in LMS use at U-M; fixed-effects regression models assessed the degree to which course-specific factors affected C-Ss; and a 3-level latent growth curve model assessed instructor-specific factors along with changes over time. Given the importance of the C-S to the ways LMS use was quantified and assessed, a brief overview of this measure is

provided below. Following this overview, I describe dominant patterns in LMS use across 19,091 course sites at U-M (RQ #2). After describing dominant patterns in LMS use, I outline the effects of various course-specific factors (RQ #2a). I then describe results from the latent growth curve model that illustrate the effects of specific attitudes toward the LMS (RQ #2b) and how instructors' use of the LMS changed over time (RQ #2c). Lastly, to supplement these analyses, I describe three instructors' use of the LMS in detail.

Overview of Course Complexity-Score

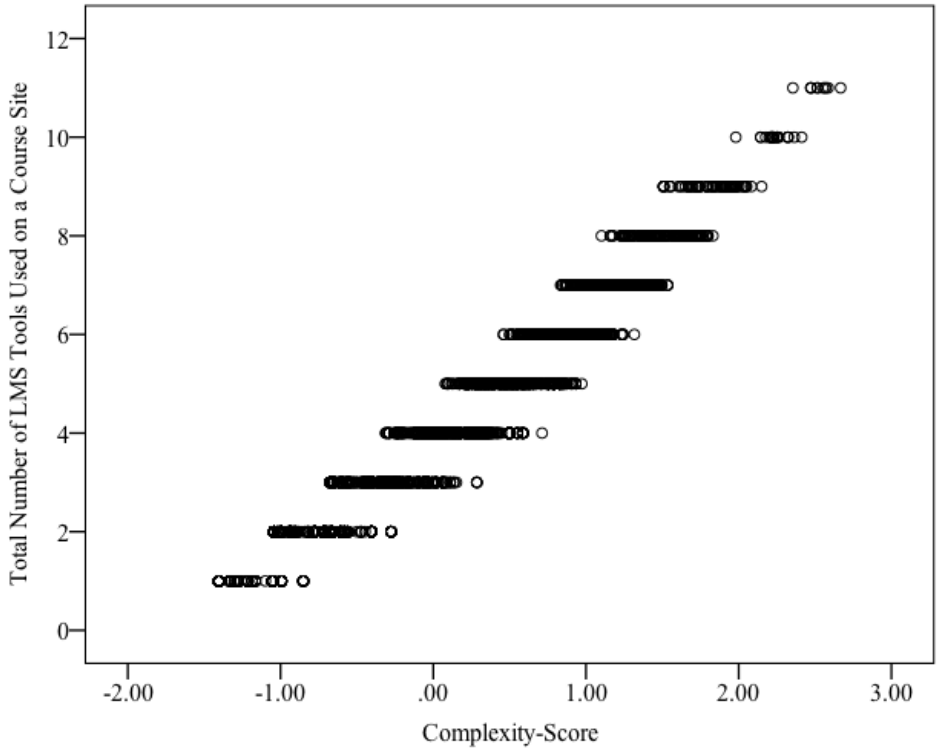
The C-S is a composite score that assigns a unique value to specific combinations of LMS tools used on a course site. One benefit of the C-S as a single score is that it can be used as a dependent variable in regression models aligned with research questions #2a, #2b, and #2c. Because the C-S is a single score, however, there are tradeoffs in terms of what it represents. Using a 2-Parameter Item Response Theory (IRT) model, the C-S represents the numbers and types of tools used on a course site. One tradeoff of the C-S is that it does not capture the degree to which a tool was used. However, being a single score afforded the opportunity to compare course sites deploying different combinations of tools on a common scale based on the overall frequency with which tools were used in specific combinations.

C-Ss at U-M, over the six semesters in which data were collected, ranged in value from -1.404 to 4.071. These values correspond to and differentiate among course sites using anywhere from one to eleven LMS tools, in various combinations. The ways in which the C-S uniquely identified specific combinations of LMS tools are presented in

Figure 5. This figure arrays the C-S on the X-axis, and the Y-axis represents the total number of tools used on a course site. There is a general trend where the more tools used on a course site led to higher C-Ss. There are also instances where course sites with fewer overall tools received a higher C-S. This can be observed in the horizontal band of points created at the intersections of C-Ss and total numbers of tools used on a course site. For example, there are multiple course sites using four tools that received higher C-Ss than those using five tools.

The range of C-Ss within a group of course sites that used the same number of tools but different combinations of tools, demonstrates the added value of the 2-parameter IRT modeling strategy used to assess LMS use in this study. For example, there were 1,538 courses that used 6 tools on a course site. For course sites using six tools, C-Ss ranged from .458 to 1.32. This range was created based on the six specific tools, out of the fourteen possible, that were used on a course site. The different values created by the C-S, therefore, generated greater levels of sensitivity in comparing course sites using the same number of total tools. Moreover, the types of tools that were used also created instances where the sheer number of tools did not contribute as much to the C-S as the use of specific tools. Similar differentiations among sites with the same as well as different total numbers of tools, in different combinations, can be seen in Figure 5.

Figure 5. Scatterplot of Total Tools Used by Course Complexity-Score



IRT modeling is typically used to score psychometric and achievement tests. The distinctions between IRT and classical test theory models, such as factor analysis, are multiple, but one key distinction is that the probability of a respondent correctly answering an item is a function of both a person's ability and an item's difficulty. Framed in terms of LMS use, the probability of an instructor using an LMS tool is a function of his or her "ability" and the "difficulty" of the LMS tool. Ability and difficulty in terms of LMS use have different connotations than are typically assumed by psychometricians. Therefore, for the purposes of this study, the statistical assumptions of IRT modeling were leveraged without utilizing the psychometric language attached to them. The features of IRT modeling leveraged to understand depth of LMS use at U-M were the frequency with which a tool was used across all course sites and the weight that each tool

contributed to the latent trait score, i.e., the C-S. In Table 11, the frequency with which a tool was used and its unique weight is referred to as the Tool Parameter and Discrimination Parameter estimates, respectively. A further affordance of using IRT modeling to examine LMS use is that LMS tools and C-Ss can be compared on the same scale. The benefit of this comparability is that it provides the opportunity to understand the probability that a course site with a specific C-S is using a particular tool. For example, if a course site's C-S is higher than the Tool Parameter than there is a greater than equal chance that the course site is using that tool.

Dominant Patterns

One way depth of implementation is characterized in this study is through the lens of patterns of LMS tools used. These patterns were operationalized in the form of a single metric, the C-S, in order to parse sources of variation and track changes over time using various regression models. These dominant patterns can serve as a baseline for understanding the full range of patterns witnessed at U-M. The C-S represents combinations of LMS tools that were used on a course site, and Table 11 presents descriptive statistics for how individual LMS tools contributed to the C-S. The first column, Percent of Course Sites, demonstrates the ratio of course sites using a particular tool. The most frequently used tool is Announcements (89.7%) and the least frequently used tool is Test Center (1.4%). The Tool Parameter column presents a model-based estimate for the likelihood that a tool was used on a course site. This column differs somewhat from the Tool Parameter Column, which accounts for the use of a given tool in relation to other tools used on a course site.

Table 11. Learning Management Item Response Theory Tool Statistics

Tool	% Course Sites	2-Parameter IRT Model Statistics				
		Tool Parameter	SE	Discrim. Parameter	SE	Point Biserial Corr.
Resources	88.8	-4.414	.318	.286	.023	.157
Announcements	89.7	-2.449	.082	.552	.027	.266
Syllabus	44.1	.209	.025	.393	.014	.268
Assignments	27.0	.871	.027	.587	.019	.386
Drop Box	35.0	.901	.045	.351	.014	.269
Discussion	23.8	1.432	.051	.439	.016	.338
Calendar	12.6	1.589	.039	.660	.022	.460
Gradebook	18.9	2.036	.089	.390	.018	.250
Chat	13.5	2.228	.079	.463	.019	.332
News	5.9	3.208	.141	.478	.024	.361
iTunes	6.6	3.960	.239	.374	.024	.254
Test Center	1.4	4.231	.317	.523	.047	.304
Polls	1.6	4.311	.301	.516	.043	.278
Wiki	2.5	4.584	.300	.444	.033	.272

As noted above, IRT models provide the opportunity to compare LMS tools and C-Ss on the same scale. For example, with a C-S of .5, the likelihood that a course site used a particular tool can be examined in relation to a tool's Tool Parameter estimate. In this example, a C-S of .5 indicates that this course site has an equal chance of using the Resources, Announcements, and Syllabus tools. The histogram of C-Ss presented in Figure 6 illustrates the entire population of C-Ss at U-M. Combined, the Tool Parameter column on Table 11 and the histogram of C-Ss in Figure 6, present an overarching depiction of the patterns of LMS use at U-M. The most frequently used tools include Resources (88.8%) and Announcements (89.7%). The Tool Parameter estimates for each of these tools are -4.41 and -2.44, respectively. Based on the values of the X-axis in Figure 6, every course site had a greater C-S than these estimates. These figures signal that every course site at U-M had a greater than equal chance of using these tools.

Syllabus and Assignments, the next two tools based on their Tool Parameter estimates reveals that 44.1% and 27% of course sites used these tools, respectively; yet, the probability that a course site had a high enough C-S to have an equal chance of using these tools is greatly diminished. The 75th percentile for C-Ss is .334, which indicates that fewer than 25% of all course sites had an equal chance of using any tool with an estimate higher than that of the Syllabus tool (.209). The patterns evidenced through an initial gloss of the Tool Parameter column demonstrate that across all course sites at U-M the most frequently used individual tools include Announcements, Resources, and Syllabus; moreover, that these tools are used in combination with other tools reveals that these three, and these three alone, have an equal chance of being used on more than 75% of course sites.

The probabilities of using an LMS tool across all course sites supports an understanding of dominant patterns in LMS use because they examine all possible combinations of LMS tools deployed at U-M. Based on the frequency with which combinations include specific tools, Tool Parameter estimates and C-Ss provide a way to assess whether any one combination is comprised of a specific tool. The distribution of C-Ss and Tool Parameter estimates are thus useful in understanding how specific tools are used in combination with other LMS tools. The Percent of Course Sites using a tool in Table 11, provide a less probabilistic way to describe the frequency with which LMS tools are used. These percentages reveal, much like the Tool Parameter column, that Resources and Announcements are used on over 88% of all course sites and that Syllabus and Drop Box are the next two most frequently used tools. These percentages, while they do not demonstrate how these tools are used in combination with others, illustrate an

overarching pattern of LMS use at U-M whereby tools used to manage course materials and communicate with an entire class are the most frequently deployed.

These patterns can also be examined across academic units on campus. Figure 7 presents histograms of C-Ss for all academic units. These distributions signal differences in the likelihood that course sites within specific Academic Units used tools specified in Table 11. There are distinct differences among academic units in terms of the individual distribution of C-Ss. Law, for example, had a higher concentration of C-Ss below zero than any other academic unit, whereas Nursing, Information, and Education all had higher concentrations of C-Ss above zero than other academic units. These differences are assessed inferentially under research question #2a.

Figure 6. Histogram of Course Complexity-Scores

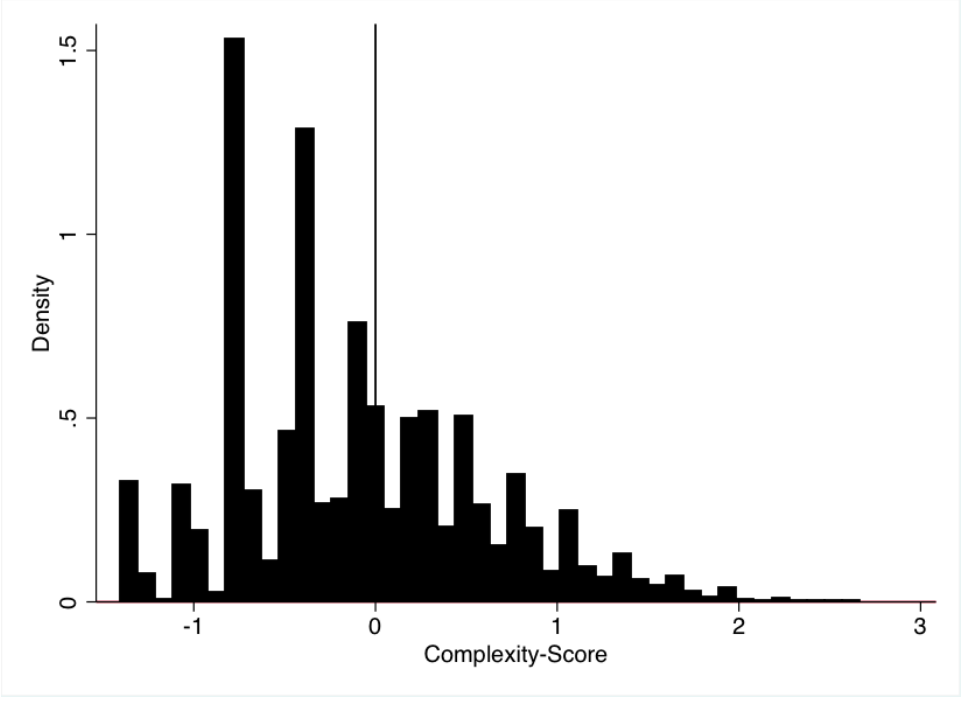
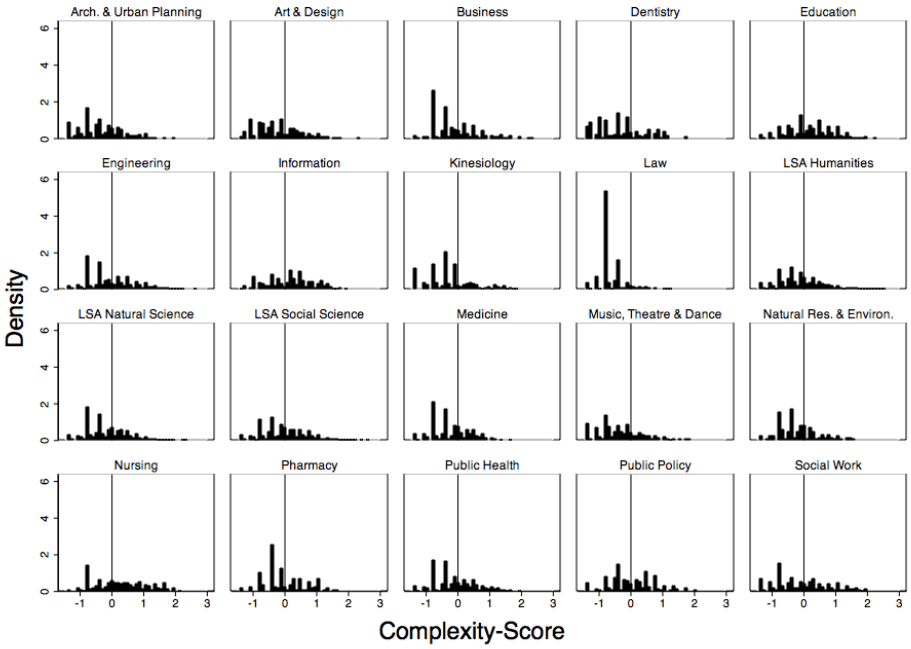


Figure 7. Histogram of Course Complexity-Scores by Academic Unit



A further less probabilistic way to capture dominant patterns in LMS use at U-M leveraged the ability of the C-S to identify unique combinations of LMS tools deployed on a course site. Table 12 represents frequency counts for each C-S, i.e., the frequency of specific combinations of LMS tools used on a course site. The LMS Tools columns in Table 12 identify the tools that comprise each pattern. Also reported on this table are the number of course sites with a specific arrangement of tools, the percent of all course sites that had that same pattern, and the C-S estimates aligned with that pattern. The most common, mutually exclusive pattern across all six semesters included Resources and Announcements, which accounted for 14.8% of all course sites. The second most common pattern included the use of Resources, Announcements, and Syllabus tools. This pattern accounted for 7.5% of all course sites, and when combined with the Resources

and Announcements pattern, these two patterns comprised 22.3% of all course sites. In total, the ten most common patterns accounted for 42.9% of all course sites at U-M.

These multiple depictions of dominant patterns of LMS use at U-M signal that the most commonly used tools are those that help instructors manage course materials (Resource, Drop Box, Assignments, and Syllabus tools) and communicate with an entire course site (Announcements). These five tools, in various combinations, made up the top eight use patterns, comprising 39.2% of all course sites. Using the C-S aligned with each of these patterns in Table 12 and the histogram in Figure 6, where these patterns fall in the full distribution of course sites' C-S at U-M can be observed. It is important to note, however, that there remains a great deal of variation among course sites based on the total number of tools used on a course site. For example, as demonstrated in Table 13, 28.4% of course sites at U-M use more than four tools. The proportion of course sites using more than four tools declined with the addition of a new tool. However, despite this decline, there were a substantial number of course sites that used a variety of tools, comprising 1,156 unique patterns. Therefore, there appear to be two dominant patterns in LMS use at U-M: one pattern made up approximately two-thirds of all course sites and captures how instructors used one to four tools to manage course materials and communicate with students. A second pattern made up approximately one-third of course sites and captures how instructors used more than 4 tools to similarly manage course materials and communicate with students with the addition of multiple tools that in some cases increased opportunities for interaction among students and instructors. The following analyses further unpack how LMS tools were used at U-M and explore how various patterns in LMS uses can be explained by course- and instructor-specific factors.

Table 12. Top Ten Learning Management System Use Patterns

Count of Course Sites	Percent of Course Sites	Complexity-Score	LMS Tools					
			Announcements	Resources	Syllabus	Assignments	Drop Box	Discussion
2816	14.8	-.778	X	X				
1422	7.5	-.404	X	X	X			
822	4.3	-.449	X	X			X	
600	3.1	-.098	X	X	X		X	
550	2.9	-1.404		X				
438	2.3	.172	X	X	X	X		
422	2.2	-1.053	X					
409	2.1	-.160	X	X		X		
369	1.9	-.352	X	X				X
350	1.8	-.008	X	X	X			X

Note: Eight tools are not displayed because they were not used.

Table 13. Total Number of Tools Used on Course Sites

Total Number of Tools	Number of Course Sites	Percent	Cumulative Percent
1	1217	6.37	6.37
2	4054	21.24	27.61
3	4529	23.72	51.33
4	3869	20.27	71.60
5	2643	13.84	85.44
6	1538	8.06	93.50
7	720	3.77	97.27
8	347	1.82	99.09
9	136	0.71	99.80
10	27	0.14	99.94
11	11	0.06	100.00

Course-Specific Factors

To understand factors affecting LMS use, two general strategies were attempted. One strategy addressed how course-specific factors explain patterns in LMS use. A second strategy examined how instructor-specific factors explain LMS use. The effects of course-specific factors were assessed using a fixed-effects regression model where individual C-Ss were regressed on the following variables for 19,091 course sites: level of the course (Undergraduate), number of students on a course site (16-23 Students, 24-44 Students, Greater than 45 Students), academic unit (Architecture & Urban Planning to Social Work), and semester (Winter 2008 to Winter 2010). Two interaction terms were included in Model 2: (1) level of course and number of students on a course site and (2) level of course and academic units. These interactions were included, but not interpreted, to control for the fact that large enrollment courses are often undergraduate courses and some academic units on campus teach few undergraduate courses.

Based on the estimates presented in Table 14, undergraduate courses, on average, had higher C-Ss, than graduate courses (Model 2, $B = .136$, $p < .001$). In Model 2, this main effect is interpreted in line with interaction terms controlling for the number of students enrolled on the course site along with the academic unit in which the course site was located. Effects for the number of students enrolled on a course site increased over each level of the variable compared to the reference category of 4-15 students: 16-23 students (Model 2, $B = .157$, $p < .001$), 24-44 students (Model 2, $B = .188$, $p < .001$), >45 students (Model 2, $B = .259$, $p < .001$). Across the 20 academic units, several significant differences were identified. The highest parameter estimates included Nursing (Model 2, $B = .531$, $p < .001$), Information (Model 2, $B = .365$, $p < .001$), and Education (Model 2,

B = .374, p < .001), and the lowest estimates included Law (Model 2, B = -.414, p < .001), Dentistry (Model 2, B = -.410, p < .001), and Kinesiology (Model 2, B = -.409, p < .001). Estimates for time fixed-effects presented a statistically significant increase for the Fall 2008 (Model 2, B = .068, p < .01) and Winter 2009 (Model 2, B = .042, p < .05) semesters and then a statistically significant decrease for the Winter 2010 (Model 2, B = -.040, p < .001) semester. These differences among level of the course, number of students, academic unit, and semester demonstrate that LMS use varied systematically across multiple course-specific factors.

Results from this regression model single out important sources of variation related to LMS use at U-M. As the above model demonstrates, undergraduate courses differ significantly from graduate courses, and this difference increases as the number of students increases on a course site. Along with these generic differences that cut across academic units on campus, when academic units are factored into understanding differences in LMS use, several of the descriptive patterns identified in Figure 7 hold within a regression framework. For example, course sites in Nursing and Education used more tools than those in Dentistry and Kinesiology. Given the robustness of the differences identified above, LMS use can be argued to vary systematically across the level of course taught, the number of students on a course site, and the academic unit in which the course site was located.

Table 14. Fixed-Effect Estimates for Course-Specific Factors

	Model 1		Model 2	
	B	SE	B	SE
Intercept	-.347***	.021	-.346***	.036
Undergraduate	.127***	.015	.136***	.037
16-23 Students	.155***	.014	.157***	.025
24-44 Students	.193***	.015	.188***	.025
Greater than 45 Students	.207***	.015	.259***	.028
Architecture & Urban Plan.	-.128***	.037	.012	.037
Art and Design	-.095*	.041	.260	.206
Business	.015	.025	.007	.045
Dentistry	-.190***	.046	-.410***	.067
Education	.357***	.034	.374***	.059
Engineering	.091***	.019	.094*	.044
Information	.374***	.043	.365***	.054
Kinesiology	-.178***	.038	-.409**	.142
Law	-.396***	.031	-.414***	.045
LSA Natural Science	-.105***	.018	-.129*	.058
LSA Social Science	.094***	.015	.022	.043
Medicine	-.020	.046	.017	.060
Music, Theatre & Dance	-.183***	.031	-.049	.093
Natural Res. & Environ.	.085	.059	.081	.067
Nursing	.436***	.034	.531***	.063
Pharmacy	.129*	.063	-.010	.090
Public Health	.137***	.032	.131**	.046
Public Policy	.221***	.054	.224**	.066
Social Work	.165***	.036	.160**	.049
Winter 2008	-.018	.018	-.017	.018
Fall 2008	.069***	.018	.068***	.018
Winter 2009	.041*	.018	.042*	.018
Fall 2009	-.013	.017	-.013	.017
Winter 2010	-.040*	.017	-.040*	.017
Undergrad X Num. Students			Yes	
Undergrad X Academic Units			Yes	
R^2	. 069		.072	

Note: *=p<.05, **=p<.01, ***=p<.001

Instructor-Specific Factors and Changes Over Time

The above model demonstrated that LMS use varied across several course-specific factors. The following model assessed the impacts of several of instructor-specific factors along with the degree to which instructors modified their use of the LMS over time. The following instructor-specific factors were assessed using a 3-level latent growth curve model: instructors' self-reported levels of technology use (Use of technology), perceptions of value for LMS uses (Learner-Learner [L-L], Learner-Content [L-C], and Learner-Instructor [L-I] Interactions), attendance at an LMS workshop (Workshop), years taught in higher education (Less than 1 year to Over 30 years). A growth term (Growth) was also modeled and was ordered from 0 to 5, where changes over time represent an average per semester change. For this statistical test, course sites were nested within instructors within academic units and the growth term was modeled as a random effect. This modeling strategy provided the opportunity to examine sources of variation across multiple levels of the model (i.e., within- and between-instructors as well as between-academic units).

Model 1 in Table 15 presents an unconditional variance components model that assessed the degree of variation in the C-S at course, instructor, and academic unit levels. This model demonstrated that 51.17% of the variance in the C-S was attributable to course-to-course differences within instructors, 40.45% was attributable to between-instructor differences, and 7.7% was attributable to differences between academic units. Variation between academic units was statistically significant; yet, larger proportions of variance were accounted for within- and between-instructors. The percentage of within-instructor variation indicates that a typical instructor significantly varied the amount and

types of LMS tools that he or she used across courses. Despite variation across courses for one instructor, however, a great deal of variation exists between instructors. The multiple instructor-specific factors outlined above were included in Model 2 in an attempt to explain this between-instructor variation.

The strongest instructor-specific predictor was the amount of technology that an instructor deployed in his or her class. On average, the more technology an instructor used, the higher his or her C-S (Model 2, $B = .125$, $p < .001$). Among the three attitudes measured, perceptions of value for L-I interactions (Model 2, $B = .079$, $p < .001$) and perceptions of value for L-L interactions (Model 2, $B = .038$, $p < .05$) were positive, significant predictors for an instructor's C-S. Whether an instructor participated in an LMS related workshop was a significant predictor at the 10% level (Model 2, $B = .066$, $p < .10$). The number of years that an instructor taught in higher education demonstrated a general negative trend, with statistically significant relationships for instructors who have taught for 11-20 years (Model 2, $B = -.128$, $p < .01$), 11-20 years (Model 2, $B = -.090$, $p < .05$), and for more than 30 years (Model 2, $B = -.284$, $p < .001$). Findings from instructor-level analyses demonstrate that there are factors unique to an instructor that explain his or her use of LMS tools. While multiple factors were identified, whether an instructor changed his or her use of the system over time (Growth, $B = -.013$, $p > .1$) did not lead to a statistically significant finding.

Table 15. Growth Curve Estimates for Instructor-Specific Factors

	Model 1		Model 2	
	B	SE	B	SE
Intercept	.005	.048	-.288**	.077
Course level				
Growth	-.012	.007	-.013	.007
Instructor level				
Use of technology			.125***	.019
L-L Interaction			.038*	.016
L-C Interaction			-.004	.016
L-I Interaction			.079***	.017
Workshop			.066~	.036
Less than 1 Year			-.032	.062
6-10 Years			-.040	.044
11-20 Years			-.128**	.041
21-30 Years			-.090*	.046
Over 30 Years			-.284***	.052
Variance components	Estimate	% Variance	Estimate	% Reduction
Level-3	.0380***	7.15%	.0311***	18.16
Growth	.0003**	0.06%	.0004**	-33.33
Level-2	.2150***	40.45%	.1873***	12.88
Growth	.0057***	1.07%	.0057***	0
Level-1	.2725**	51.27%	.2725***	0

Note: ~=p<.10, *=p<.05, **=p<.01, ***=p<.001

The instructor-specific factors assessed in the above model demonstrate that like course-specific factors, several factors unique to individuals represented significant sources of variation related to LMS use. Along with the findings that an instructor's general use of technology and perceptions of value for L-L and L-I interactions were significant positive predictors related to C-Ss, another important finding from the above analyses is the degree to which LMS use varies within and between instructors as well as academic units. The variance components derived from these models highlight how on a course-to-course basis, instructors vary the degree to which they use the LMS. However, when averaged across all of the courses that an instructor teaches, perceptible patterns

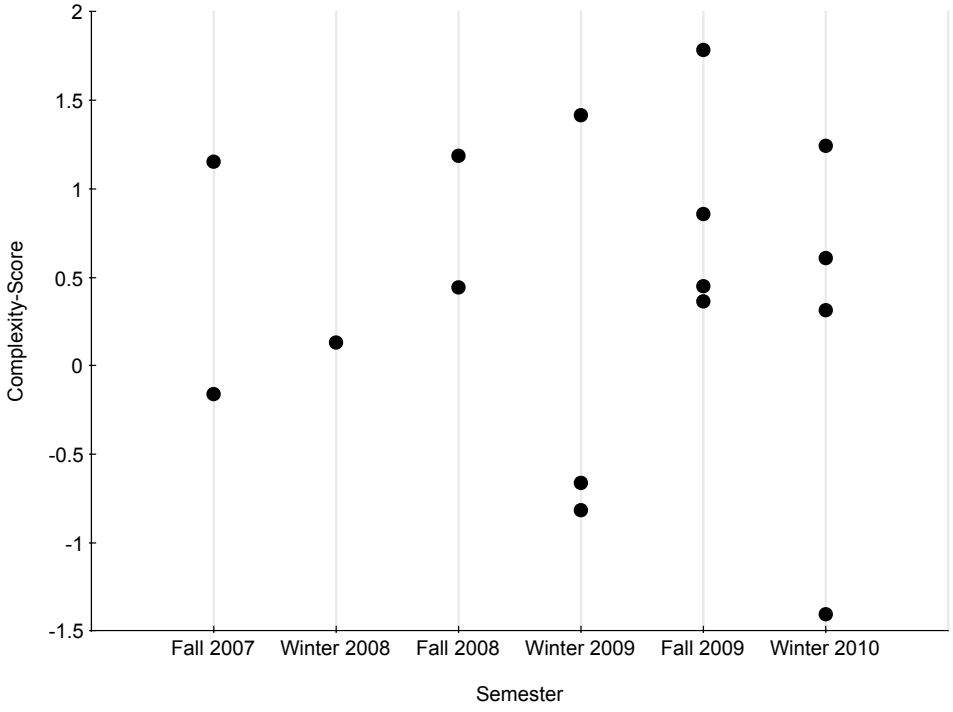
emerge between instructors. The variation that was observed between-academic units represents an interesting juxtaposition in relation to the parameter estimates identified in the fixed-effects model. In that model (See Table 14), several differences were observed between academic units. This fixed-effects model, however, did not control for the correlations among course sites taught by the same instructor. When this source of variation was assessed in the 3-level latent growth curve model, only a relatively small amount of variation was observed to have occurred between academic units (Model 1 = 7.15%). This percent of overall variation signals that larger amounts of variance exists within- and between-instructors. The instructor-specific factors that were identified signal the important ways some beliefs are related to behaviors and that the use of other technologies was positively related to use of LMS. The variation that exists within- and between-instructors demonstrates the full complexity involved in describing instructors' use of LMS tools.

Individual Cases

In an effort to make more concrete some of the models presented above, three individual cases are described below. Figure 8, for example, illustrates the utility that can be gained by examining individual cases in light of the above findings. Figure 8 demonstrates the variation that occurred within-instructors by illustrating one instructor's use of the LMS across sixteen courses. As noted in Table 15, 51.27% of variation occurred within-instructors. This means that over half of all of the variance that occurred across C-Ss was attributable to an instructor changing his or her use of the system from course-to-course. Figure 8 makes this degree of variation somewhat more concrete by

plotting one instructor's use of the LMS over six semesters. Both the variance components and the individual case highlight the important ways in which LMS use varies within an instructor, which means that, in the case of LMSs, any explanation for the degree to which instructors use an LMS must account for this level of variation.

Figure 8. Variation in One Instructor's Use Over Time



To identify individual instructors and compare them with their peers, a separate distribution from the one presented in Figure 6 was created by averaging the C-Ss for instructors across all of the courses that they taught. Each instructor received an average score. Figure 9 represents average C-Ss for 1,295 instructors. The average number of course sites per instructor was 6.89. Below, three instructor's use of the LMS is described. These three instructors were selected based on their location in the distribution of average C-Ss. The mean of this distribution is -.008, with a standard deviation of .555.

To identify cases that would demonstrate different locations in the distribution, instructors were identified with average C-Ss at or near the values of -1, 0, and 1, which represent instructors at low, middle, and high points in the distribution, respectively.

Figure 9. Histogram of Instructors' Average Course Complexity-Scores

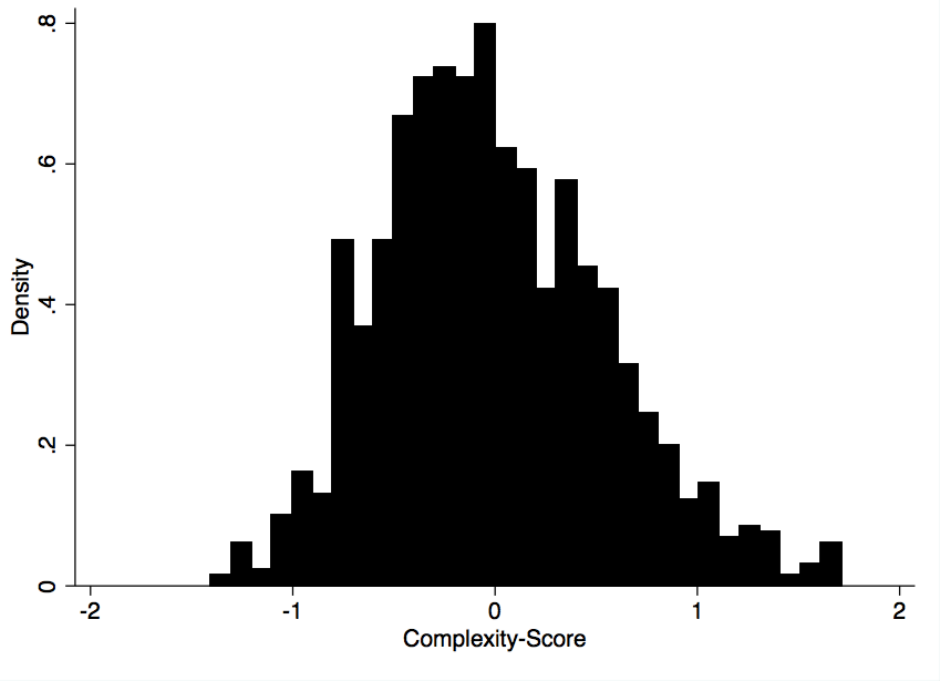


Table 16 presents instructor #1's use of the LMS, who had an average C-S of approximately -1.000. This instructor taught four courses and was located in the LSA Humanities academic unit at U-M. This instructor used the LMS in ways that aligned with the two-thirds of course sites that were created to manage course materials. This instructor is somewhat unique, however, in that he or she did not use the Announcements tool. Over 89% of course sites at U-M used this tool. This instructor used one to three tools on his or her course sites with a range in C-S estimates from -1.40427 to -.609. This

range demonstrates, again, the degree of variation that exists within instructors in how they use the LMS from course-to-course.

Table 16. Instructor Profile #1

C-S	Tools	Semester	Students
-1.404	Resources	Fall 2007	24-44 Students
-.994	Syllabus Resources	Fall 2007	24-44 Students
-.994	Syllabus Resources	Winter 2008	16-23 Students
-.609	Gradebook Syllabus Resources	Winter 2008	24-44 Students

Case #2 represents an instructor with an average C-S of approximately .001. This instructor taught three courses; yet, with much less variation than the first instructor in terms of the range among C-Ss: -.008 to .018. As illustrated in Table 17, instructor #2 consistently used more tools than instructor #1 along tools that promoted interaction among students and instructors. Instructor #2 used four tools on his or her course sites, and three of these tools stayed the same: Announcements, Syllabus, and Resources. This instructor used the most frequently tools, on average, but supplemented these three tools with the use of the Discussion tool on three course sites and Chat on another. This arrangement of tools indicates that this instructor used the LMS to manage course materials and make whole-class announcements along with providing a way for students to interact with one another. Like instructor #1, instructor #2 taught all undergraduate courses in the LSA Humanities academic unit. Another similarity is that each instructor

taught different numbers of students. Instructor #1 worked with anywhere from 16 to 44 students and instructor #2 worked with anywhere from 4 to more than 45 students per course. As the results form the fixed-effects model illustrate, on average, more students on a course site led to higher C-Ss. These cases demonstrate aspects of this general trend but also signal that deviations existed from this general trend.

Table 17. Instructor Profile #2

C-S	Tools	Semester	Students
-.008	Announcements Syllabus Resources Discussion	Fall 2007	4-15 Students
-.008	Announcements Syllabus Resources Discussion	Winter 2008	4-15 Students
.018	Announcements Syllabus Resources Chat	Fall 2009	>45 Students

Table 18. Instructor Profile #3

C-S	Tools	Semester	Students
-.098	Announcements Syllabus Resources Drop Box	Fall 2007	4-15 Students
1.766	Announcements Assignments Calendar News Polls Resources Drop Box Discussion	Winter 2008	24-44 Students
.733	Announcements Assignments Gradebook Syllabus Resources Drop Box Discussion	Fall 2008	16-23 Students
1.402	Announcements Assignments Calendar Polls Syllabus Resources Drop Box	Winter 2009	24-44 Students
1.436	Announcements Assignments Calendar News Syllabus Resources Discussion	Fall 2009	4-15 Students

Table 18 presents the course sites used by an instructor in the Public Policy academic unit who taught only graduate level courses and who had an average C-S of

approximately 1.048. This instructor, like instructor #1, evidenced a range in C-Ss among the courses that he or she taught: -.098 to 1.766. The range among these course sites, however, needs to be interpreted in relation to all of the course sites for this instructor, whereby most course sites, with the exception of one, are among the highest C-Ss observed at U-M. This instructor is unique in that, on average, undergraduate course had higher C-Ss than undergraduate courses. As with the prior two instructors, instructor #3 used tools that help him or her manage course materials. Like instructor #2, instructor #3 also used tools that helped him or her create opportunities for interaction among students using the Discussion. The remaining tools used by instructor #3 fall into a category of tools that, like Announcements, Resources, and Syllabus, help an instructor to manage various aspects of teaching a course in higher education. These extra tools, such as Calendar, Assignments, Drop Box, and Gradebook, help students and instructors manage course schedules, assignments and grades. Unlike Announcement, Resources, and Syllabus, these latter four tools are not used on as many course sites.

These individual cases provide a way to contextualize the parameter estimates identified in fixed-effects and 3-level latent growth curve models. More than any other finding from the above regression models, these cases unpack the amount of variation that existed within-instructors. Below, the ways in which the LMS was used at U-M are revisited and discussed in line with the literature cited in Chapter 5.

Discussion

The following LMS use-patterns were identified at U-M. The most frequently used tools included those that aided instructors in managing course materials and communicating with the whole class: Announcements (89.7%), Resources (88.8%), and Syllabus (44.1%). When tools were used in combination, these three tools were constituents of most combinations. For example, 14.8% of all course sites used Announcements and Resources, and only those tools. This combination made up the single largest proportion of unique combinations. More interactive tools, however, such as Discussion and Chat, did not go unused. Instead, 23.8% and 13.5% of course sites used these tools, respectively.

Based on descriptive results related to the C-S, two patterns at U-M emerged. One pattern involved approximately two-thirds of instructors using anywhere from one to four tools in managing course materials and communicating with students. One-third of instructors deployed course management tools along with tools that supported interaction between and among students and instructors. Given these proportions, the LMS at U-M, appeared to be used to make aspects of traditional instructional practices more efficient.

Several course- and instructor-specific factors were identified that helped to explain the ways in which the LMS was used at U-M. Undergraduate courses as well as larger courses all had higher C-Ss. There were also numerous differences among academic units at U-M, signaling that course content as well as distinct pedagogical styles may have affected the ways in which the LMS was used. The observation that distinct pedagogical styles may have played a role, along with differences in the content of courses, is based on work by the Carnegie Foundation and their identification of

signature pedagogies, which characterize differences among disciplines in how they teach future members of their respective disciplines (Gurun, Chick, Haynie, & Ciccone, 2009; Shulman, 2005). Differences among academic units related to LMS use may provide further evidence of the phenomena explored by these researchers. However, these differences require further investigation because the amount of variation observed between academic units in the latent growth curve model demonstrated that instructors, and not academic units, account for larger proportions of variation in LMS use.

Related to literature on technology integration, the results observed in the current study align with those made by Massy and Zemsky (1995) who argue that instructors are likely to use technologies that make elements of their work life more efficient. Course management tools, such as Resources, Announcements, Assignments, and Syllabus, help instructors to manage course materials, grade course assignments, and communicate with the whole class. These types of tools were used in courses where managing course activities may be especially important. For example undergraduate courses and courses with large numbers of students had higher C-Ss, signaling that more LMS tools were used to manage course materials and promote different opportunities for interaction among instructors and students. LMS use, in these cases, therefore, appeared to be driven by the pragmatic realities of these course-specific factors.

Drilling down to the instructor-level of analysis, several factors were correlated with LMS use-patterns, such as the amount of other technologies that an instructor used in his or her classroom. Moreover, an instructor's perceptions of value for using the LMS to promote interactions among students (Learner-Learner interactions) as well as between students and instructors (Learner-Instructor Interactions) had a positive relationship with

C-Ss. Factors that had a negative effect included the number of years one has taught in higher education.

A key factor that was examined at the instructor level included the degree to which instructors changed their use of the system over time. In the end, instructors were not identified as changing their use of the system over subsequent semesters. However, the way in which change was assessed in this study may have contributed to this finding. The way in which the growth term was modeled captured an average change across semesters. Results from the variance components analysis indicate that there is a great deal of variation in how much instructors vary their use within- and between-semesters. While some instructors vary their use of the system to minimal degrees, for a large proportion of instructors, use of the LMS varied dramatically. This level of variation may have made detecting an average effect between semesters difficult to observe.

Table 19 summarizes the findings related to LMS use at U-M. Other researchers, as noted in Chapter 5, have observed similar findings. For example, Malikowski (2008) notes the following:

> Despite the number of features available in a [LMS] and a decade of use, the most commonly used individual feature is the one that allows faculty members to transmit a file to students, such as a syllabus or assignment description. Furthermore, the current study found that when multiple features are used, the most frequent combination involves features for transmitting different kinds of information to students, such as files and grades. (p. 85)

The difference between prior studies and the analyses undertaken in the current study is that the above findings were observed for large numbers of instructors, on measures of actual use, using longitudinal techniques, and aligning measures of use with self-report measures. Based on the findings from prior researchers and the assessments of LMS use at U-M, depth of implementation related to LMSs reveals a somewhat familiar pattern to

other instructional innovations. Coburn (2003) notes that depth of implementation signals more than just an innovation being used, but the degree to which preexisting instructional practices change as a result of using the innovation. As with many innovations, few changes to underlying teaching practices may be observed in line with LMS use at U-M. Instead, for approximately two-thirds of instructors, the LMS was deployed to make preexisting practices more efficient—not to reinvent them.

Table 19. Summary of Implementation Findings

Research Question	Finding
#2. Use of LMSs	Most commonly used tools support managing course activities
	Tools that promote interaction among students and instructors are less frequently used
#2a. Course-specific factors	Undergraduate courses have a higher C-S
	C-S increases with numbers of students enrolled
	Significant differences among academic units
#2b. Instructor-specific factors	Use of other technologies positively related to a higher C-S
	Perceptions of value for L-L and L-I interactions positively related to a higher C-S
	Attending an LMS workshop has a positive effect on a C-S
	Large amount of within-instructor heterogeneity
#2c. Changes over time	No instructor-level change over time

Cohen (1987), along with Collins and Halverson (2009), argue that, in general, teachers need to reinvent their preexisting practices in order to take full advantage of a technology. Based on the dominant patterns identified in how instructors used the LMS,

there is little evidence to suggest that instructors fundamentally altered the ways in which they taught in order to take advantage of some of the features available within these systems. Only 23.8% of course sites, for example, used the Discussion tool, which was designed to promote interactions among instructors and students. Other tools intended to promote these types of interaction included Chat, Polls, and Wiki. Only Chat was used on more than 10% of course sites, and the Polls and Wiki tools were used on less than 3% of course sites, respectively. Use of these tools might signal that some underlying changes to instruction in university classrooms occurred. Instructors' low levels of use for these tools may be explained by instructors' predispositions to use LMS tools in line with their preexisting practices and an overall reluctance to expand upon their practice to take advantage of a variety of tools and uses (Georgouli, et al., 2008; Lin, et al., 2010). Instructors' low levels of use for these tools may also be explained by the fact that instructors use these types tools outside of the LMS, and thus, use of these tools can not be accounted for by analyzing system log data from the LMS, alone. There is some support for this explanation based on the positive relationship between an instructor's use of other technologies and his or her use of the LMS. However, some researchers argue that LMSs are not intended to promote changing instructional practices and that the overall design of these systems reinforces traditional teaching practices (Bongalos, Bulaon, Celedonio, de Guzman, & Ogarte, 2006; Lane, 2009). Given the robustness of prior research and the findings from the current study, instructors' preexisting practices may have been powerful factors affecting their use of the LMS.

Cuban's (1986, 2001) examinations of technology use across pre-K, K-12, and higher education organizations reveals that the most frequently used technologies are

those that help to manage day-to-day activities, such as communicating with colleagues, and not to change how teachers interact with students or how students would interact with content. How teachers interact with students and how students interact with content are often taken-for-granted aspects of teachers' professional lives, reinforced by organizational structures and incentives that are highly resistant to change (J. W. Meyer & Rowan, 1978). The assumption highlighted by Zemsky and Massy (2004) that adopting a technology will lead instructors change their instructional practices speaks to a common theme in technology-driven change, namely, improvement by revelation. Simply by having access to the technology, instructors will immediately see the benefits and deploy the technology in such a way as to achieve those benefits. Decades of implementation research reveals that when instructors encounter an innovation, if it is used at all, it is used in line with one's previous ways of doing things. As Coburn and Stein (2006) observe, innovations and policies are implicitly statements on how one set of actors would like to see another set carry out their work practices in different ways. Too often, *how* instructors are to develop these new practices remain implicit, and few supports are specified for helping an instructor enact newly desired practices.

An important question related to LMS use at U-M is as follows: do the results witnessed at U-M and other settings constitute a failure of implementation? Based on the findings related to the ways LMSs gained legitimacy presented in Chapter 4, these systems were described in relation to their ability to support instructors in managing course materials. Few descriptions posited that LMSs would transform instruction in fundamental ways. In line with these descriptions, LMSs may have provided instructors what these systems were set out to do. Despite the evidence that these systems were

described as supporting the management of course materials, multiple researchers were discouraged by their own observations that these systems were used in these ways. However, the observation that preexisting practices shape the enactment of innovations provide another way of interpreting the supposed failure of LMSs. Phrased in question form: what supports were provided to instructors to help them move beyond their preexisting practices in order to deploy the LMS in ways that some argued to be the intent of these systems?

The above question is particularly salient for LMSs because, in general, these systems constitute a "flexible" (Cohen, 1987) technology, meaning that adopters can deploy LMSs in a variety of ways. The flexibility of these tools can be witnessed in the 1,156 different combinations of tools used on over 19,000 course sites at U-M. Instructors can, and did, use the technology in myriad ways. A tension with this level of flexibility, argues Cohen, is that instructors are likely to use such flexible innovations in ways that correspond to their preexisting practice. This observation stands in stark contrast to the assumptions highlighted by Zemsky and Massy that technology will cause one to change one's practice *de novo*, but corresponds with a great deal of social science research that argues in order for an instructor to move beyond current practices, he or she must be incentivized and given the supports necessary for doing so, what Cohen and Ball (2007) refer to as "scaffolds." U-M, for example, provided limited scaffolds for instructors to extend their preexisting practices, in the form of multiple workshops. The variation in the types of workshops offered, from brief introductions to the LMS to specialized support on how to use the Wiki tool, however, may explain why this variable did not have more of an effect on instructors' use of LMS tools. Moreover, attendance at

these workshops was voluntary, and those who participated may be different on multiple measure from those who did not, which makes attending a workshop a proxy for other factors related to LMS use.

Preexisting practices are supported by a variety of institutional and organizational structures (Barley, 1986; Fountain, 2001; Orlikowski, 2000). To change one's underlying practices requires attention to these structures. Preexisting organizational structure as well as preexisting practices and beliefs of individuals are all regularly cited as shaping the implementation of an instructional innovation (Cohen & Ball, 1990; Cuban, 1993; Datnow & Castellano, 2000; McLaughlin, 1990). Preexisting organizational structures (e.g., norms, rules, and routines) support an individuals' preexisting ways of doing things and therefore can push back on the aims of an innovation. In higher education, for example, there are often unclear incentives for changing instructional practices, which can negatively impact an instructor's motivation to adopt and implement an innovation (Cuban, 1999; Schön, 1995).

Though the role of one's preexisting practices may provide some explanatory purchase in understanding the results presented in this chapter, one finding from the above analyses adds complexity to this overall argument. In short, one's preexisting practices may not be pronounced and expressed equally in all instructional settings. In the same way that researchers have identified a great deal of variation in how program implementation differs within specific units of analyses, such as schools (Rowan, et al., 2004; Zhao & Frank, 2003), this same level of variation can also be witnessed at a further level of analysis: within individual adopters. In Table 15, 51.27% of variation in C-Ss was attributable to course-to-course differences within the same instructor. This level of

variation signals that instructors modified their use of the LMS a great deal from course-to-course. Results from the fixed-effects model may help to explain this level of within-instructor variation. Factors such as the number of students enrolled in a course and the level of the course (e.g., undergraduate vs. graduate) were related to the tools used on a course site. The size of a course, for example, may engender different types of tools to be used in order to manage numerous course assignments and grades as well as to promote different interaction structures through, for example, the Discussion tool. Much of the variation within-instructors may be attributable to instructors teaching courses with these different features. Given this level of variation, therefore, there appears to be an important interaction between the different pragmatic necessities of a course and one's preexisting practices. Pragmatic necessities may provide incentives for some instructors to experiment and deploy a variety of tools.

Summary

In summary, most course sites at U-M were largely comprised of combinations of tools that supported managing course materials. Tools that supported course management activities had the lowest tool parameter estimates in Table 11 and tools that supported interactions among students, such as Discussion, Chat and Wiki, had some of the highest estimates. Moreover, only two of the top ten patterns in LMS uses included a tool that supported interactions among students and instructors. Tools with higher parameter estimates that did not necessarily support interactions among students or support managing course materials, such as Calendar, Gradebook, and Test Center, form another category of tools that are similar to Resources, Announcements, and Syllabus, in that they

support regular features of course activities, but whose added value may not extend beyond what instructors typically use to accomplish these tasks, such as a course syllabus for maintaining the course schedule, an Microsoft Excel spreadsheet for maintaining course grades, and paper forms of tests. These other sets of tools fall within the one-third of course sites that deploy more frequently used course management tools along with tools supporting additional forms of interaction among instructors and students. While up to one-third of course sites may use a diverse set of tools, for two-thirds of course sites, LMS use is limited to a handful of tools for providing materials to students and one-way communication with the whole class. Despite these overarching patterns related to LMS use, large amounts of variation were observed in how instructors deployed the LMS from course-to-course. Instructors, on average, tended to use the LMS to support basic managerial work; however, there was enough variation in how the LMS was used to signal more complex decision-making on the part of instructors. Combined, findings from this chapter provide robust depictions of observations that were made in prior small-scale studies, add nuance to traditional explanations for the enactment of instructional innovations (e.g., the role of preexisting practices), and point to intriguing future lines of research (e.g., How much does the use of other instructional innovations vary within-instructors?).

CHAPTER 8: CONCLUSION

Multiple technologies have been presented as solutions to improving teaching and learning in university classrooms (Nespor, 2006; Willinsky, et al., 2011). While technology is often promoted as a solution to improving teaching and learning, few technologies find themselves in regular use by instructors or students. In this dissertation, I examined the diffusion and implementation of one of the few learning technologies to have been widely adopted across higher education and used by thousands of instructors—learning management systems (LMS). The questions explored in this dissertation centered on understanding why LMSs diffused to the degree that they did along with understanding how instructors actually used these systems in university classrooms.

Organizational scholar, James March, writing in the late 1980s, addresses factors influencing the diffusion of learning technologies in higher education in the following way:

> The diffusion of modern information technology may have consequences for education, but its acceptance in higher education is only partly tied to its practical educational usefulness. Things spread through societies and institutions for many reasons, only some of them connected with their instrumental contribution. We imitate one another and produce fads without assuring their social or personal value…. Much of the adoption of a new technology depends on the symbolism it evokes. And whatever else it may be or become, the computer and the terminal work station are symbols of a modern university. University administrators and faculties advertise their commitments to computer technology with as much vigor as they do their commitments to progress and social welfare, and the

> advertisements are believed to augment individual and institutional esteem. (1987, p. 16)

Adopting technology, as March argues, is an important way for universities to maintain an image of a "modern university" and to cultivate "institutional esteem." The need to integrate technologies has been a consistent pressure on universities for decades (Cuban, 2001). However, most efforts at responding to these pressures fall victim to a familiar pattern: elevated rhetoric around possible responses, varying degrees of diffusion for some responses, and all too often, limited use by instructors and students. In many ways, the "symbolism" and "institutional esteem" cultivated by a university in its adoption of a technology often does not filter down into how instructors teach and students learn (Spillane, Gomez, & Mesler, 2009).

How did LMSs diverge from the all-to-common fate of elevated rhetoric, limited diffusion, and non-use in classrooms? In this dissertation, I provided the following explanations. First, LMSs largely avoided the elevated rhetoric that often accompanies the "next new thing" (Abrahamson, 1991; Abrahamson & Fairchild, 1999). Instead, many of the unreasonable expectations were ascribed to other technologies, such as the Internet. Second, LMSs achieved widespread diffusion because they became a legitimate technology for universities to adopt in the face of increasing pressure to integrate technology into university classrooms. Third, LMSs were regularly used in university classrooms because they allowed instructors to make certain course management tasks more efficient without having to change preexisting instructional practices. These three explanations, however, do not stand alone; they are interrelated. For example, LMSs were not described as revolutionary technologies but as technologies that could support instructors manage courses materials, which were exactly how instructors used them in

classrooms at the University of Michigan (U-M). Moreover, LMSs were legitimated as an innovation in response to the pressures implied through the often-unreasonable expectations ascribed to other technologies, such as the Internet.

The diffusion of an innovation is often dependent upon the ways in which it is deemed a legitimate action to take (Davis & Greve, 1997). The legitimacy of an innovation is related to the degree of social consensus that emerges around what it is and the problems it will solve (Strang & Meyer, 1993; Tolbert & Zucker, 1996). How universities were supposed to respond to calls for integrating technology during the late 1990s and early 2000s was far from certain. However, as the rhetoric around the Internet called into question the future viability of colleges and universities, they found a solution in LMSs that was being described and justified in ways that made concrete specific uses for the Internet and solved important problems facing university administrators who were in charge of purchasing enterprise level technologies and managing relationships with individuals outside of the university.

The need for universities to adapt to a changing technological landscape is highlighted by the recent removal and reinstatement of the president of the University of Virginia (UVa) (Stripling, 2012). The president of UVa, Teresa A. Sullivan, was removed in the summer of 2012 because some regents saw her as not doing enough to keep UVa at the forefront of online learning (Hebel, 2012). The removal of a president is one action that a university can take in response to changing environmental conditions, and the episode at UVa throws into relief multiple ways legitimacy can play a role in an organization's response to changing environmental pressures. On the one hand, a university—a highly valued and taken-for-granted institution in its own right—must

continually work to maintain its own legitimacy (Kraatz & Zajac, 1996). This legitimacy, for example, helps the organization secure resources necessary for its continued existence (J. W. Meyer & Rowan, 1977). One way the regents at UVa saw as critical to maintaining its organization's legitimacy was to develop online learning opportunities. Importantly, however, removing the president was not deemed a legitimate response. If the response were deemed legitimate, it is plausible that removing the president would have been described and justified in such a way as to gain social consensus and a degree of appropriateness. The reinstatement of president Sullivan, however, signals that no such consensus emerged. It may be too early to tell whether the removal of university administrators is an appropriate response to changing environmental conditions *per se*, but the high visibility of one UVa regent's failure demonstrates that this response is not likely to diffuse widely.

As a strategy for responding to environmental pressures, removing academic administrators stands in stark contrast to adopting an LMS. For these systems, the stakes were seemingly just as high for universities as they worked to maintain legitimacy as organizations in the shadow of innovations, such as the Internet. LMSs represented one way universities could respond. These systems eventually diffused widely because they were described and justified in ways that elevated their legitimacy as a response for universities. Rhetorical analyses revealed that LMSs provided a certain amount of currency in the institutional realm for colleges and universities; adopting an LMS cast a university in a favorable light, as an organization that was responding to a changing technological environment. However, use of LMSs in a majority of classrooms at U-M

demonstrated that, despite their legitimacy as an organizational response, LMSs provided limited impact on what took place inside of classrooms.

The diffusion and implementation of LMSs, therefore, presents an ironic reality—LMSs are one of the few technologies to diffuse widely; yet, these systems' actual impact on teaching and learning has not been as dramatic as their spread throughout higher education. Instructors at U-M, for example, did make broad use LMS tools, which stands in opposition to previous innovations that were adopted by universities but not used in classrooms (Cuban, 2001). Recognizing that LMSs were used in classrooms, but in limited ways, highlights a series of tensions related to the role of technology in promoting more dramatic change to teaching and learning. One tension involves the flexibility of an innovation, itself. If adopters can easily modify an innovation, then individuals will use the innovation in line with their preexisting practices (Cohen, 1987). Flexible innovations, however, increase the odds that more individuals will adopt the tool precisely because they do not need to change their prior ways of doing things. Less flexible innovations, on the other hand, often require changes to preexisting ways of doing things, which can be hard work (Rubenstein & Pugh, 2006). As Cohen (1987) argues, changes to preexisting instructional practices are often required for dramatic learning gains to occur. For example, students in university classrooms are not likely to experience dramatic learning gains if an instructor simply integrates an LMS into a traditional course organized around lectures and exams. In this example, the ways in which the instructor organizes the class is the most proximal factor affecting learning (Cohen, et al., 2003). Interestingly, if the LMS was a less flexible tool, one that required an instructor to organize his or her course around, for example, small-group activities,

then it is much less likely that instructors would have adopted the LMS in the first place. Put simply, the very flexibility of the LMS may have contributed to its popularity but also to its limited effects on how instructors teach and how students learn.

Related to this tension is a second. As Cohen and Moffitt (2009) argue, if dramatic change is the goal, then adequate resources must accompany the innovation. If an instructor was presented with a less flexible version of an LMS that required him or her to organize class time around small-group activities, what would this instructor need in terms of knowledge, skills, and dispositions to accomplish these changes to entrenched instructional practices? Luckily for LMSs, no such knowledge, skills, or dispositions were required to use these systems to minimal degrees. However, based on results on how instructors used these systems at U-M, knowledge, skills, and dispositions played an important role in explaining differences for how instructors used these systems. The degree to which an instructor used other technologies in his or her instruction (knowledge and skills) along with how much he or she valued specific interactions supported by the LMS (dispositions) were positive predictors for increased LMS use. The source of these knowledge, skills, and dispositions remain objects of speculation because much like the technological innovations that came before them, LMS were largely introduced to universities without the resources necessary to support instructors' development of new capacities in order to use them effectively. U-M, however, did provide workshops to help instructors develop capacity related to using the campus LMS, and results indicate a weak relationship between attending a workshop and instructors' increased use of LMS tools. While a weak overall relationship was identified, it does point to the possible role that

resources outside the innovation can play in effecting more dramatic change to teaching and learning opportunities in university classrooms.

What lessons can be learned from the diffusion and implementation of LMSs? For university administrators, it is clear that how they support their organization in responding to environmental pressures can incur high costs. On the one hand, an administrator can spend large sums of money on the "next new thing" that is subsequently not used by students or instructors. Here, the costs are literal, and involve "wasted" financial resources. On the other hand, as was the case with online learning at UVa, university administrators can make costly mistakes that damage the reputation of the organization. In each case, attempts by administrators to maintain organizational legitimacy can be affected by the legitimacy conferred on the action taken. The difficulty for administrators is that predicting which courses of action will be deemed legitimate is difficult. There are certain advantages to be gained by setting trends in adopting an innovation before it is deemed legitimate across an organizational field. For example, early adopters can increase their status among peers along with experience more flexibility in modifying an innovation to fit their specific needs (Strang & Soule, 1998; Zucker, 1983). However, as noted above, actions taken before they are deemed legitimate can incur both financial costs and costs to one's reputation.

For designers of learning technologies, one implication from the analyses conducted in this dissertation is as follows: if designers wish to develop a system that will be used widely, they need to target practices that are shared by large numbers of instructors. In higher education, designing a system used to the same degree that LMSs are involves designing a system that can be used by instructors in fields as diverse as

physics and philosophy. The question then becomes for a designer: what activities are common across large numbers of learning environments? For LMSs, these activities included sharing a course syllabus, organizing course readings, and posting course grades. These activities, in the end, centered more on managing a course as opposed to managing or meaningfully intervening on student learning. Moreover, the structure of higher education emphasizes the development of flexible innovations that can be adopted in multiple, diverse settings (Kratz & Zajac, 1996), and for an innovation to gain traction across diverse instructional settings, it must be flexible in order to match this diversity. Flexibility, however, has tradeoffs in that accommodating the needs of diverse adopters often means designing for the lowest common denominator: the more specified the innovation is in terms of how it is to be used, the more likely the mismatch between the innovation and large numbers of adopters. Learning technologies that have had demonstrable impacts on teaching and learning are often well specified and address clearly delineated content areas and problems of teaching (Spillane, et al., 2009). Technologies such as these often require accompanying resources that advance the capabilities of potential adopters, which come with inherent resource costs. While costly, the ways in which LMSs were used at U-M points to importance of these accompanying resources, and ultimately to the role that designers play in pairing these resources with a technology.

Limitations

The narrative developed in this dissertation was accompanied by various limitations. One limitation involved tracing how LMSs were described and justified using

a single publication, the *Chronicle of Higher Education*. For the purposes of this study, subtle meanings related to descriptions and justifications were identified, which implied tradeoffs in the number of texts that could be analyzed. Because each text needed to be read multiple times, fewer texts, overall, could be included in my analysis. The limited number of texts that could be coded also implied that limited numbers of innovations could be examined, whereby the robustness of the rhetorical patterns identified in this dissertation could be enhanced through the inclusion of different types of innovations, such as the rhetoric aligned to blogs or mobile learning platforms. Therefore, cross-case analyses involving other innovations could serve as useful comparisons and support a richer understanding for how innovations gain legitimacy.

Related to the above limitations, the ways in which individuals interacted with the descriptions and justifications ascribed to LMSs were not assessed in this study. While specific rhetorical patterns were identified, how individuals actually interacted with these patterns (e.g., how frequently do individuals read the CHE?) and if individuals made meaning from these patterns in the way described in this study remain speculative. Lastly, because diffusion was framed in relation to discursive practices, other factors known to affect diffusion were not assessed. An important underexplored question is the amount of variance in diffusion patterns that is explained by rhetorical patterns in relation to other factors, such as the makeup of an organization's social network (e.g., G. F. Davis & Greve, 1997).

An important contribution of this dissertation is that it explored users' actual interactions with the focal innovation at the scale of an entire university. One limitation of these analyses, however, is that they only explored LMS use at one university. While

several of the patterns observed at U-M have been witnessed at other universities, several of the findings related to specific attitudes, variation in LMS use, and tools used may not be generalizable beyond similarly structured universities using a similar LMS. Moreover, U-M has a unique history of developing its own software and was a founding member of a consortium of universities that developed the Sakai LMS. Therefore, not only does U-M's size, research focus, and population of instructors and students affect the generalizability of the findings presented in this dissertation, so too does U-M's unique history related to learning technologies in higher education.

While this study accurately assessed what tools were being used, why those tools were used and the specific instructional purposes to which they were put were not. Questions such as these are important to understanding the efficacy of LMSs on outcomes, such as student learning, because the ways in which instructional resources are used moderates their effectiveness (Cohen, et al., 2003). While a descriptive analysis of implementation was the goal of this study, more information from instructors and students on how they were putting the innovation to use could provide important information related to the patterns observed at U-M. If, as the label used throughout this dissertation implies, these systems are related to managing "learning," future work needs to assess the ways in which these systems do or do not do just that.

A further limitation of the analyses related to LMS use is the years for which LMS patterns were analyzed, 2007-2010. LMSs have been on university campuses since the mid-1990s and at U-M, in various forms, for nearly a decade. It is reasonable to speculate, then, that patterns of use associated with the LMS of U-M may be an artifact of history, whereby instructors had become settled in their use of the system and the

relevant years for detecting growth or experimentation were not included in the years examined in this study. An attempt was made to gather all system log data for the LMS at U-M since its inception, which was approximately 2005; however, the structure of pre-2007 data made it difficult to download, aggregate, and analyze. Expanding the relevant study years to incorporate the entire life of the innovation may have revealed different use patterns, especially as they relate to changes over time.

Recommendations for Future Research

Several future lines of research can be identified from this dissertation. Three lines come directly from the limitations stated above. The first area of future research is related to tracing the rhetoric accompanying multiple innovations. To better understand the effects of legitimacy on the diffusion of learning technologies, or instructional innovations more generally, requires multiple examples, for which there is no shortage. How, for example, have data driven decision making tools, or in their more modern guise—learning analytics-based innovations—been described and justified, and what impact have these descriptions and justifications had on their diffusion? A better understanding of these patterns could help sensitize practitioners and researchers to possible factors affecting decisions to adopt these and related innovations.

Along with assessing similarities and differences in rhetorical patterns across innovations, a second line of future research points to assessing the particular ways in which actors appropriate and enact various rhetorical elements accompanying the diffusion of innovations. These assessments point to critical sensemaking mechanisms (Coburn, 2004; Spillane, et al., 2011), and interviews with key actors, such as university

administrators, or broad-based surveys could be used to detect the ways in which actors make sense of and base decisions on the ways innovations are described and justified.

A third line of future research involves measuring various aspects of instruction related to the implementation of an innovation. As noted above, if these systems are thought to manage learning, system log data-based analyses supplemented by observations of classrooms and interviews with users could provide important insights into how these systems are integrated into instruction. The use of system log data in this dissertation provided a way to develop robust measures for how LMSs were actually deployed in university classrooms. Therefore, extensions of this research require analyses that contextualize the use of LMSs within instruction and measuring, for example, the one-off impacts related to their use. For example, how does providing course materials through an LMS create new instructional time in traditional lecture-based courses? Added instructional time may be an indirect benefit of LMS implementation; yet this benefit can only be evaluated through an understanding of what is occurring in actual classrooms. In line with observations made by Cohen et al. (2003), measuring how an innovation fits within interactions among teachers, students, and content is critical to understanding the efficacy of any intervention. The salience of these observations to future LMS research involves assessing how the LMS was integrated into actual instructional practices in and across university classrooms. Capturing how LMSs fit within instruction is an important unanswered question at the scale attempted in this study. The use of system log data in this dissertation provided the opportunity to capture *what* tools were used, measuring how LMS tools are used within instruction may support a better understanding for *why* they were used the way they were.

As schools and universities face a continually shifting technological landscape, understanding what factors affect the spread of one innovation over another as well as the possible effects of adopting an innovation on teaching and learning will continue to be important areas of concern for both practitioners and researchers. This dissertation examined the diffusion and implementation of LMSs to clarify many of these concerns. That LMSs achieved wide scale adoption signals that they were able to succeed where many others have failed. Questions remain as to whether their potential to impact teaching and learning have come and gone or are yet to be realized.

APPENDIX A

Chronicle of Higher Education Texts analyzed in this dissertation.

C1 The virtual college. Jacobson, Robert L. The Chronicle of Higher Education. Washington: Jan 27, 1995. Vol. 41, Iss. 20, p. A21. (3 pp.)

C3 Campus 'intranets' make information available to some, but not all, Internet users. Wilson, David L. The Chronicle of Higher Education. Washington: Aug 2, 1996. Vol. 42, Iss. 47, p. A15. (2 pp.)

C4 On line Anonymous. The Chronicle of Higher Education. Washington: Jan 24, 1997. Vol. 43, Iss. 20, p. A23. (1 pp.).

C5 Wave of the future or a waste? UCLA requires Web page for every class. Jeffrey R Young. The Chronicle of Higher Education. Washington: Aug 1, 1997. Vol. 43, Iss. 47, p. A21-A22. (2 pp.)

C6 Workshops and 'mini grants' give Iowa professors a technological edge. Kelly McCollum. The Chronicle of Higher Education. Washington: Oct 10, 1997. Vol. 44, Iss. 7, p. A26. (1 pp.)

C7 A new industry sprouts up to help professors put courses on line Kelly McCollum. The Chronicle of Higher Education. Washington: Oct 31, 1997. Vol. 44, Iss. 10, p. A33-A34. (2 pp.)

C10 A philanthropy puts millions into asynchronous learning. Goldie Blumenstyk. The Chronicle of Higher Education. Washington: Nov 13, 1998. Vol. 45, Iss. 12, p. A23-A24. (2 pp.)

C11 A new career track combines teaching and academic computing. Lisa Guernsey. The Chronicle of Higher Education. Washington: Dec 11, 1998. Vol. 45, Iss. 16, p. A35-A37. (3 pp.)

C12 Top business schools seek to ride a bull market in on-line M.B.A.'s. Katherine S Mangan. The Chronicle of Higher Education. Washington: Jan 15, 1999. Vol. 45, Iss. 19, p. A27-A28. (2 pp.)

C13 Textbooks and tests that talk back Lisa Guernsey. The Chronicle of Higher Education. Washington: Feb 12, 1999. Vol. 45, Iss. 23, p. A21-A22. (2 pp.)

C14 The marketing intensifies in distance learning. Goldie Blumenstyk. The Chronicle of Higher Education. Washington: Apr 9, 1999. Vol. 45, Iss. 31, p. A27-A30. (3 pp.)

C15 Technology 'outsourcing': The results are mixed. Goldie Blumenstyk. The Chronicle of Higher Education. Washington: Oct 29, 1999. Vol. 46, Iss. 10, p. A59-A64. (4 pp.)

C16 A medieval strategy for a digital age. Perry Glasser. The Chronicle of Higher Education. Washington: Nov 19, 1999. Vol. 46, Iss. 13, p. B9-B10. (2 pp.)

C17 New technology companies go after academics for their boards. Goldie Blumenstyk. The Chronicle of Higher Education. Washington: Feb 4, 2000. Vol. 46, Iss. 22, p. A47-A48. (2 pp.)

C18 Wisconsin joins Pentagon project to ease transfer of software for online courses. Sarah Carr. The Chronicle of Higher Education. Washington: Mar 3, 2000. Vol. 46, Iss. 26, p. A43-A45. (2 pp.)

C19 A study produces a list of 24 benchmarks for quality distance education. Dan Carnevale. The Chronicle of Higher Education. Washington: Apr 7, 2000. Vol. 46, Iss. 31, p. A45. (1 pp.)

C20 Swarthmore College sells its popular mathematics site to WebCT. Dan Carnevale. The Chronicle of Higher Education. Washington: Apr 28, 2000. Vol. 46, Iss. 34, p. A51. (1 pp.)

C21 George Washington U. tries to sell software it created to put courses online. Sarah Carr. The Chronicle of Higher Education. Washington: Jun 9, 2000. Vol. 46, Iss. 40, p. A47. (1 pp.)

C22 The bubble bursts for education dot-coms. Sarah Carr, Goldie Blumenstyk. The Chronicle of Higher Education. Washington: Jun 30, 2000. Vol. 46, Iss. 43, p. A39-A40. (2 pp.)

C23 New project brings peer review to Web materials for teaching. Jeffrey R Young. The Chronicle of Higher Education. Washington: Jul 28, 2000. Vol. 46, Iss. 47, p. A56. (1 pp.)

C24 How a publishing empire is changing higher education. Goldie Blumenstyk. The Chronicle of Higher Education. Washington: Sep 8, 2000. Vol. 47, Iss. 2, p. A43-A46. (3 pp.)

C25 How publishing companies are changing academe. Anonymous. The Chronicle of Higher Education. Washington: Oct 6, 2000. Vol. 47, Iss. 6, p. B6. (1 pp.)

C26 Strictly business at a community college. Andrea L Foster. The Chronicle of Higher Education. Washington: Nov 3, 2000. Vol. 47, Iss. 10, p. A40. (1 pp.)

C27 At a religious black college, the Internet is seen as a tool and a temptation. Dan Carnevale. The Chronicle of Higher Education. Washington: Nov 3, 2000. Vol. 47, Iss. 10, p. A41. (2 pp.)

C28 Army picks consulting group to run distance-education effort Sarah Carr. The Chronicle of Higher Education. Washington: Jan 5, 2001. Vol. 47, Iss. 17, p. A46.

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