ABSTRACT

Title of Dissertation:	LEVERAGING COMPLEXITY SCIENCE TO PROMOTE LEARNING ANALYTICS ADOPTION IN HIGHER EDUCATON: AN EMBEDDED CASE STUDY
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The Society for Learning Analytics Research (SoLAR) defines learning analytics as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (SoLAR, n.d.). To fully realize the potential of learning analytics, especially in its perceived ability to reveal previously hidden aspects of the learning process, researchers have called for more intentional approaches in order to harness resources and affect change. These researchers argue that without this coordinated effort to integrate learning analytics into the fabric of higher education institutions, the field will continue to languish, with learning analytics tools and approaches left forever incapable of affecting more systemic change.

At the same time, other researchers focused on leadership and change management have recognized the difficulty, if not impossibility, of such top-down approaches. Instead, many researchers have pointed to the need to view higher education institutions through the lens of complexity science, and, in particular, to consider higher education institutions as complex

adaptive systems (CAS) in which change tends to happen through the process of emergence. Within such a paradigm, change occurs from the ground up, as a result of countless interactions among many different agents (students, educators, and administrators, to name a few).

Recognizing this conflict between the sort of top-down approaches suggested by many learning analytics researchers, and the ground-up reality recognized by many complexity science researchers, this dissertation project investigates how learning analytics usage is happening within a higher education institution. Using an embedded case study methodology to examine current learning analytics practices across multiple academic units and stakeholders within a single higher education institution, I apply a CAS framework to determine how this institution might expand and grow their approach to learning analytics across key areas.

LEVERAGING COMPLEXITY SCIENCE TO PROMOTE LEARNING ANALYTICS ADOPTION IN HIGHER EDUCATON: AN EMBEDDED CASE STUDY

by

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Dedication

For Amanda and Louisa.

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Thank you to my wife and daughter for supporting me through this process and for always cheering me on.

Thank you to everyone in TLL and the College of Education at the University of Maryland. In particular, thank you to Diane for taking me on as a graduate student, and for helping me make it across the finish line.

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List of Abbreviations

LA	Learning Analytics
LAD	Learning Analytics Dashboard
LAI	Learning Analytics Implementation
LMS	Learning Management System
CAS	Complex Adaptive System

Chapter 1: Introduction

The Society for Learning Analytics Research (SoLAR) defines learning analytics as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (SoLAR, n.d.). For much of the relatively short history of the field, learning analytics researchers have focused primarily on developing and testing new technologies that perform this measurement, collection, analysis, and reporting. In particular, learning management systems (LMS) have spawned not only new learning environments but also vast stores of learner-related data. Armed with this data, researchers argue, learning analytics might unmask previously hidden or altogether new aspects of the learning process, empowering stakeholders at all levels.

As Ismail, et al., (2021) describe, throughout higher education in particular there is the belief that "the data produced from the LMS [can] be transformed effectively into meaningful information" as well as "to reflect on the learners' interaction within a system. Moreover, this can improve the understanding of the user's [behavior] and characteristics that contributes to low LMS usage" (pp. 73-74). As Duin & Tham (2020) concur, "there is a strong sense across higher education that academic and learning analytics will pay significant dividends if administrators and instructors but mine the [LMS] data available to create 'actionable intelligence' with the goal of increasing efficiency, effectiveness, and student success" (p.3).

As institutions continue to invest in both developing and integrating learning analytics tools based on LMS and other data sources, researchers are increasingly interested in the policies and processes by which these tools are, or should be, adopted and used across educational contexts. In some ways, this shift in attention – from a narrow focus on tools to the intentional implementation of those tools – answers a call made at the Fourth International Conference on Learning Analytics and Knowledge (LAK '14), that "in order to truly transform education, learning analytics must scale and become institutionalized at multiple levels throughout an educational system" (Arnold, et al., 2014).

Wise & Vytasek (2017) designate the term "learning analytics implementation" to refer specifically to the "act of introducing learning analytics into an educational environment" and "the purposeful framing of activity surrounding how analytic tools, data, and reports are taken up and used as part of an educational endeavor" (pp. 151-152). This "purposeful framing" usually denotes a commitment to coordination across the numerous administrative, technology, and academic stakeholders within an institution, with a desire of establishing the development and integration of learning analytics for a common goal. A commitment to this holistic approach to learning analytics has generated numerous models intended to lead institutions through the implementation process. Most notably, the RAPID Outcomes Mapping Approach (ROMA) considers learning analytics implementation as a sequential, hierarchical process which starts with setting policy objectives and leads through the development of a monitoring and learning system (Ferguson, et al., 2014). The ROMA model has been further refined with Supporting Higher Education to Integrate Learning Analytics, or SHEILA (Tsai, et al., 2018). The SHEILA framework urges educational leaders to carefully consider infrastructure, management, ethics, privacy and other issues related to the various steps in the learning analytics implementation process.

These models reflect what Dawson, et al. (2018) characterize as an "instrumental approach" to learning analytics implementation, which harnesses a "top-down leadership model" and "a shared and pre-established symbolic cause for implementation and resourcing" (p. 242). These idealized models outline a significant level of forethought, planning, and resource allocation in order to realize the proposed gains of learning analytics implementation at a system level. In contrast are those institutions, or those various entities within a single institution, which can be considered "emergent innovators" and represent a "bottom-up model of adoption…more associated with the developing alliances among independent units" (Dawson, et al., 2018, p. 243). For many if not most institutions, especially vast, de-centralized institutions without a clear learning analytics mandate, the classification of "emergent innovators" is one way of depicting the reality across much of higher education: that individuals are approaching learning analytics – and teaching and assessment more broadly – in their own unique ways, without much, if any, direction from others in their immediate academic unit contexts or from other institutional directives.

Drawn from the field of complexity science, the concept of *emergence* refers to a phenomenon that cannot be understood as originating from the system level; thus, how learning analytics implementation is happening among these emergent innovators cannot be understood as the result of a top-down directive. This depiction of emergent innovators points to a pluralism of learning analytics happening within higher education institutions. Moreover, this depiction suggests that the phenomenon of learning analytics must be understood from the ground up, starting in the more specific contexts in which they emerge.

Accordingly, my research hopes to capture the complicated nature of learning analytics and related teaching and learning activities within a single higher education institution through the lens of complexity science. While many researchers remain focused on arguing for the need of coordinated, system-level learning analytics directives, my project seeks to better understand what potential learning analytics-relevant resources, practices, and processes already exist, and how institutions and the broader field of learning analytics may understand, leverage, and bolster current structures to further expand learning analytics usage from the ground up.

Among a variety of competing definitions of *emergence*, Ostroff, et al. (2012) offer the following description which focuses on both the materials and the processes that lead to emergence:

> Elemental content is the raw material of emergence and refers to the cognitions, affect, perceptions, or mental representations. Interaction denotes the process of emergence (e.g., how elemental content becomes shared) through communication and information exchange, sharing of ideas, exchanging work products and other forms of interactions among employees. In combination, the elemental content and form of the interaction process comprises the emergent phenomenon (p. 660).

Using this schema, my approach to understanding the purpose and form of learning analytics seeks to identify the "elemental content" and "interactions" that contribute to the emergence of learning analytics implementation across a higher education institution. In particular, I investigate multiple stakeholders from multiple academic units from a single higher education institution to determine how learning analytics is envisioned and being used across different contexts. In part, my research project is a process of peeling back the layers of current learning analytics-related practices in an effort to arrive at actionable goals for the future.

Specifically, I seek to answer the following research questions:

1. *What types of learning analytics do stakeholders employ, and for what purposes?*
2. *What are stakeholders' teaching and learning backgrounds and experiences, and to what teaching and learning related resources do they have access?*
3. *How might institutions leverage and support current learning analytics structures and practices?*

As an embedded case study grounded in social constructivism, my qualitative research project depends on the results of semi-structured interviews with various stakeholders across multiple academic units within a single higher education institution. As Merriam (2002) describes, this sort of research project begins with "the idea that meaning is socially constructed by individuals in interaction with their world…there are multiple constructions and interpretations of reality that are in flux and that change over time" (p. 4). Thus, I begin this research with the understanding that learning analytics is not a homogenous concept or tool, but instead a broad, arguably nebulous, umbrella under which numerous definitions, purposes, and capabilities can be found. My first research question seeks to capture what might be these many – sometimes overlapping, sometimes conflicting – definitions, purposes, and capabilities of learning analytics according to various stakeholders. Not only do I hope to uncover a variety of learning analytics usage across academic units, but I also seek to understand the relationship between what stakeholders think and believe about learning analytics and what they are actually doing.

My second research question hopes to uncover and delineate the material and any other circumstances that help to explain current learning analytics-related practices. In the same way my first research question seeks to depict a multitude of learning analytics-related activity, my second research question seeks to uncover how there is, likewise, no single pathway towards, no single recipe for, the implementation of learning analytics across diverse contexts, even within a particular higher education institution.

My third research question seeks to determine how institutions might build on this knowledge in an effort to support current practices and, potentially, expand learning analytics throughout higher education institutions. Through the lens of complexity science, my goal is to offer other pathways, beyond typical top-down mandates, that might lead towards wider learning analytics adoption.

Dawson, et al. (2018) claim that only by understanding the nature of emergent innovators might institutions be able to determine how best to harness them, and, perhaps, integrate them into a more coherent learning analytics strategy. In this vein, my analysis seeks to identify points of previously unknown intersection among seemingly disparate academic units and their various stakeholders, and, ideally, future opportunities for potential interaction if not collaboration in the realm of learning analytics implementation. Equally as important, I hope to identify those areas of difference, and possibly conflict, and offer recommendations on how institutions might address these disparities in the future.

Chapter 2: Literature Review

To provide a theoretical foundation for this dissertation, the following literature review is divided into three main sections: Learning Analytics, Learning Analytics Implementation, and Complexity Science. Learning analytics is a relatively young and still growing field, and this first section provides a brief history as well as an overview of the tools that have been designed and studied over time. In the second section, learning analytics implementation is presented as its own distinct sub-field, with researchers concerned with the intentional development and integration of learning analytics tools into educational contexts, usually at the institutional or system level. Finally, with the concept of emergence central to my research and analysis, I provide a background in the field of complexity science, including the particular construct of complex adaptive systems (CAS), which are often used to describe a variety of aspects relating to higher education institutions, as well as the concept of emergence.

Learning Analytics

In the following section, I start by providing an overview of the advent of learning analytics, built on the foundation of programmed instruction in the 1950s and, over the course of several decades, through the development of intelligent tutoring systems (ITS). With this history, I then discuss Learning Management System (LMS) data and, following, learning analytic dashboards (LADs) – the most prominent learning analytics tool that appears throughout the literature – with discussion and examples related to three learning analytics users: students, teachers, and administrators.

The Rise of Learning Analytics

In some ways, the field of learning analytics can be traced back to the educational psychologist B.F. Skinner (1958), whose work on programmed instruction in the 1950s eventually laid the foundation for the development of intelligent tutoring systems (ITS). Programmed instruction is an approach to teaching that uses a self-paced, step-by-step method intended to make the learning process more efficient and effective. Skinner developed a number of instructional devices, including a modified slide projector called the Teaching Machine, which might be considered the very first ITS, the evolution of which over the last several decades eventually overlapped with the rise of the learning analytics field in the early 2000s.

ITS started in the 1960s and 1970s when researchers including Patrick Suppes (1968) began exploring the use of computers to deliver personalized instruction. The first systems were based on programmed instruction and used simple rule-based methods to provide feedback to students. Later, in the 1980s, there was a shift towards more complex, knowledge-based tutoring systems, with the development of systems like the Geometry Tutor and the Algebra Tutor (Mitrovic & Ohlsson, 2013). These systems used cognitive models to provide personalized instruction to students within particular disciplines. Cognitive Tutors were developed in the 1990s, with these systems using algorithms to model student learning and adapt the instruction in real time. In particular, the Cognitive Tutor Algebra system demonstrated significant improvements in student learning (Anderson, et al., 1995). In the 2000s, the growth of the Internet and the increasing availability of educational data led to the development of web-based ITS. These systems, like ASSISTments (Hefferman & Koedinger, 2016) and AutoTutor (Graesser, et al., 2018) have continued to expand ITS research, integrating machine learning and natural language processing to facilitate increasingly personalized instruction.

The intersection of ITS and what would eventually be referred to as "learning analytics" began in the 2000s when researchers started using data from ITS to develop predictive models of student learning. These models were used to inform the design of ITS and provide feedback to both students and teachers. Other researchers in the field of educational technology began to explore the potential of data and analytics to improve the effectiveness of education, particularly through early e-learning courses (Siemens & Long, 2011).

In the 2010s, the field of learning analytics began to expand rapidly, driven by advances in technology and the growing availability of data in education, in large part due to the proliferation of learning management systems (LMS). These systems have become increasingly sophisticated, and many LMS now include built-in analytics tools that allow educators to track student progress and performance. Indeed, it is this transition of the entire teaching and learning endeavor – not only certain components of particular disciplines through ITS, like geometry or algebra, but entire academic courses, educational programs, and even institutions – from the physical classroom to LMS and other virtual spaces that have given rise to learning analytics.

A number of organizations and initiatives have formed to support and advance the field of learning analytics. The IMS Global Learning Consortium first developed the Learning Tools Interoperability (LTI) standard in 2010, which allowed different educational systems to share data and communicate with each other (IMS Global, n.d.). Most notably, the Society of Learning Analytics Research (SoLAR) was established in 2011. SoLAR organizes its annual International Conference on Learning Analytics & Knowledge (LAK), and publishes the *Journal of Learning Analytics*. The journal covers a wide range of topics related to learning analytics, including the design, development, implementation, and evaluation of learning analytics tools and techniques, as well as the ethical and social implications of learning analytics. Some of the most cited learning analytics studies and literature reviews, many of which will be referenced throughout this dissertation, first appeared in the *Journal of Learning Analytics*.

Learning Management System (LMS) Data

As presented, the majority of learning analytics studies are based on LMS data. Studies from the last two decades have focused on identifying available data points that might be used for such purposes as student performance modeling, student behavior modeling, grouping students, as well as basic analysis and visualization.

For student performance modeling, studies range from those attempting to determine traits that lead to learner success to those traits that lead to learner failure. For example, McCuaig and Baldwin (2012) examine LMS activity, including number of days that learners were active in the LMS and number of times learners looked at assignments, to determine if and how these activities relate to success in a course. Conversely, Macfadyen and Dawson (2010) examine a broad range of LMS activities to create an early warning system to identify students who may not succeed in a course.

In terms of student behavior modeling, Hershkovitz and Nachmias (2011) investigate the trait of student persistence in the context of online learning, attempting to determine behaviors of students who choose to remain in courses. Similarly, Krüger et al. (2010) track learner use of a series of self-evaluation exercises, determining if completion of one exercise related to completion of another. While these types of studies might easily translate into issues of learner performance, the primary investigations concern discrete learner behaviors.

The difference between the category of grouping students and the previous two categories can often be explained by statistical modeling approaches. The performance and behavior modeling categories are more often related with approaches attempting to predict (pass or fail, retention or drop out), while grouping is often linked to the approach of clustering. As one example, Castro et al. (2005) track several LMS learner activities and use generative topographic mapping to cluster students. The purpose is not to determine which behaviors lead to better or worse performance or behavior; rather, the goal is simply to determine which activities are typical of learners and which are not.

Analysis and visualization usually entail mining data collected from LMS and applying basic statistical operations. For many of the other tasks, researchers must first aggregate data to determine counts, sums, and averages to which they can then apply machine learning and other techniques. For general visualization, these basic statistics are the goal. For example, Monk (2005) uses log data to determine how often learners use different course materials while Jovanovic et al. (2007) use the LOCO-Analyst tool to capture learner performance on a quiz at the level of individual questions. Today, many LMS provide summaries and visualizations of these basic statistics through their own learning analytics dashboards (LADs).

Learning Analytics Dashboards (LADs)

Among the variety of learning analytics tools that cater to learning, teaching, and administration, many can be identified as dashboards. Learning analytics dashboards (LADs) are typically a page or display, or series of pages and displays, that aggregate, summarize, and often visualize data about learners, learning processes, or learning contexts. These data often originate from LMS and related teaching and learning applications, but they can also include other available student data related to demographics, enrollment, grades, and anything else that an institution might have access to and be able to integrate.

Studies and literature reviews on LADS abound, often focused on categorizing LADs according to certain features. For example, in their systematic review of empirical learning analytics studies, Matcha, et al. (2019) grouped LADs into the following categories: 1) competency tracking, 2) game-based learning, 3) emotion tracking, 4) study planning, 5) learning difficulty detection, 6) teamwork progress tracking, and 7) learning design tracking. With some overlap, Bakharia, et al. (2016) identify the following LAD display types: 1) temporal analysis, 2) cohort dynamics and patterns, 3) contingency and decision support tools, 4) tool specific analysis, and 5) comparative analysis.

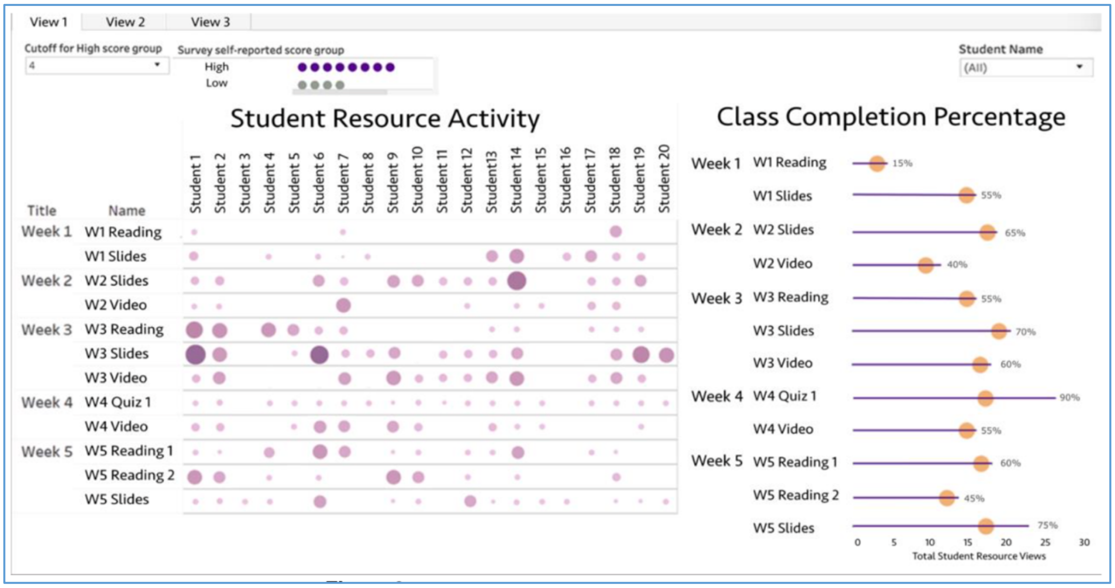
In terms of student-facing LADs and other tools, the focus is on directly enhancing the learning process for students themselves. Bodily & Verbert (2017) identify five main areas for learning analytics for student learning: 1) encouraging awareness or reflection, 2) recommending resources, 3) improving retention or engagement, 4) increasing online social behavior, and 5) recommending courses. These learning analytics tools intend to improve the student experience by increasing engagement in classes while also providing more easily accessible subject- and course-related resources. This sort of student-directed learning analytics is probably most related to certain versions of ITS as previously discussed.

Considering student-facing LADs specifically, Jivet, et al. (2017) offer three reference frames: social, achievement, and progress. Social dashboards show individual learners how they compare to the rest of a class, sub-groups within classes, previous students, or high achievers. Most of these dashboards provide averages. For achievement dashboards, information is framed either in terms of learning outcomes set by teachers or, in fewer cases, learning goals set by students themselves. Data included on these dashboards can include, for example, assessments of key terms used by students in discussion board activities or quiz performance. Finally, progress dashboards allow learners to see their progress over time, providing access to historical data.

Focusing specifically on teacher-facing learning analytics tools – those tools designed to help teachers reflect on their teaching materials and methods – Sergis & Sampson (2017) identify three main purposes: 1) analyzing educational design in terms of elements, 2) capturing the flow of learning and assessment activities, and 3) analyzing learning and assessment activity types. These learning analytics tools attempt to help teachers visualize how they organize and manage their classes, helping them to analyze activities to facilitate reflection and deeper understanding of course design.

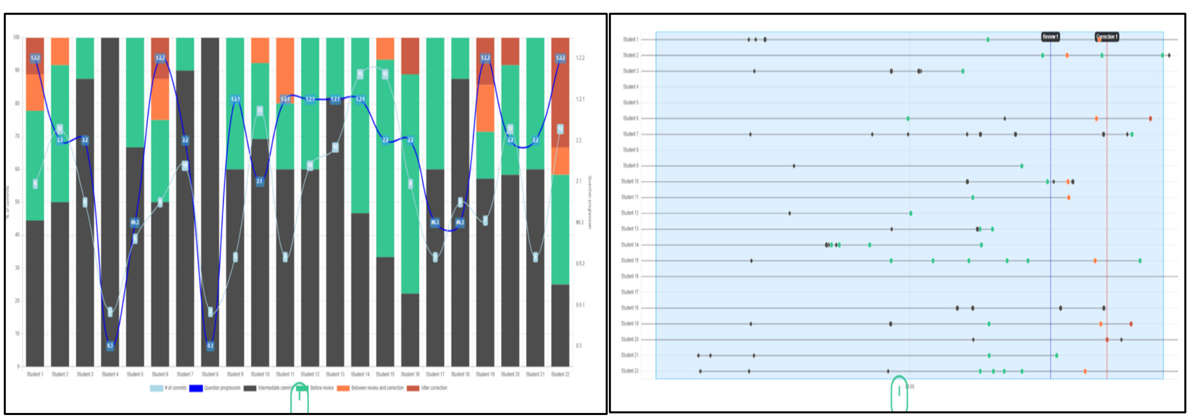
Though research relating to LADs and other tools for teachers is relatively scarce, some recent examples include Ahn, et al. (2019), who describe both the design and implementation process of the dashboard tool Edsight, intended uniquely for middle school math teachers to reflect on their teaching practices. As another recent example, seen in ***Figure 1***, Wise & Jung (2019) worked with instructors across disciplines both to develop a dashboard that integrates data from across a university system, including the registrar, the LMS, and tools like quizzing systems and streaming videos that have been integrated into the LMS.

Figure 1. Dashboard image retrieved from Wise & Jung (2019)



Providing examples of other teacher-facing LADs, both Jones (2019) and Van Leeuwen (2018) describe professional development opportunities intended to help teachers more effectively use already existing dashboards to inform their teaching. As seen in ***Figure 2***, Raclet & Silvestre's (2020) Git4School provides visualizations based on data extracted from student work, allowing teachers to design planned interventions.

Figure 2. Dashboard images retrieved from Git4School (n.d.)



Finally, there are learning analytics tools meant for administrators, usually at the institution or system level, with the most prevalent being tools intended to improve student retention. In this case, administrators and researchers alike hope to understand the relationships between student activity and keeping students enrolled in institutions, often with the goal of targeting "at risk" students (Beer, et al., 2019; Clark & Tuffley, 2019; Heath & Fulcher, 2017). Many LADs and other tools are coupled with functionality for such interventions, including "nudges," or automated attempts to engage with students perceived to be struggling or not meeting some threshold, like logging into the system within a certain timeframe, usually through email or other communication through an LMS. These nudging and other interventions have been implemented at both the individual teacher and the institutional level (Beer, et al., 2019; McKee, 2017; Lawson, et al., 2016).

In their recent review, Valle, et al. (2021) describe what various dashboards actually provide. Among the LADs included in the study, 96% used descriptive statistics while only 18% integrated some type of predictive statistics. Visualizations included both graphs as well as metaphors or images to aid students' understanding of the information. Some LADs heavily depended on additional text to provide guiding questions to scaffold student learning. Many of these LADs incorporated color-coded messages, traffic light metaphors, and other elements such as social network representations and timelines.

As described, much of learning analytics research focuses on presenting particular tools, usually LADs, that attempt to improve the learning process in a variety of ways, with the intended users of these tools including students themselves, teachers, administrators, or a combination thereof. When considering the learning analytics field across the full educational landscape, the majority of studies relate to higher education, with a variety of literature reviews focused specifically on the development of learning analytics capabilities within higher education contexts (Avella, et al., 2016; Leitner, et al., 2017; Tsai & Gašević, 2017). Zhong's (2015) analysis of 60 studies identifies five main research areas related to learning analytics in higher education, with approximately half of these studies focused on teaching and learning, and the other half focused on administration, technology development, and digital citizenship, including ethical and privacy issues.

Typical of the field, including many of the studies referenced so far, much of learning analytics research is descriptive, focused on presenting tools, describing how and why these tools were designed a certain way, and only sometimes offering results, usually from pilot or case studies. A common criticism of the field is not only a lack of a true theoretical foundation but also a scarcity of evidence that these learning analytics tools and approaches actually help. In their analysis of 252 learning analytics studies, Vibrerg, et al. (2018) found just 35% of studies providing evidence for learning analytics improving either learning support or teaching in higher education, and only 9% providing evidence that learning analytics actually improves student learning outcomes. Speaking to the relative lack of studies concerning broader learning analytics implementation, these researchers found that a mere 6% of studies provided evidence of learning analytics being adopted systematically throughout higher education institutions.

Learning Analytics Implementation

Moving forward from this history of the learning analytics field, and an overview of what learning analytics tools and related research include, this section returns to the issues of meaningful framing and intentional implementation. While there is an abundance of learner-related data, from LMS and elsewhere, and an increasing number of LADs and other tools that can synthesize and represent that data for various users, the issue remains of how to effectively develop and disseminate those tools so they are actually used to achieve relevant, measurable outcomes. In the following section, I start by establishing the need for context-specific implementation processes, as identified by a handful of governments and higher education institutions that have conducted large-scale implementation analyses. Next, I provide an overview of the range of learning analytics implementation frameworks and models that researchers have offered over the last two decades. Finally, I focus specifically on Wise & Vytasek's (2017) learning analytics implementation (LAI) model.

Context-Specific Implementation

As repeated throughout the learning analytics field, a variety of stakeholders at all levels must be engaged during the design and implementation process of a LAD or other tool. As Kaliisa, et al. (2023) argue, "the potential of LA dashboards to support teaching and learning will only be realized if researchers and technology developers think differently not only about who is involved in the design and implementation of such dashboards but also about how they are involved" (p. 19). Further compounding the issue is the diversity of educational contexts, with different contexts representing different problems and opportunities that demand different tools. As Macfadyen, et al. (2014) warn, "no one-size-fits-all prescriptive approach to policy and strategy development for educational change is available or even possible" (p. 24).

Many higher education institutions and even governments have highlighted their interest in the processes of implementing learning analytics tools and the contextual elements affecting successful implementation. As one of the most comprehensive accountings of learning analytics efforts at scale, a European Commission Joint Research Centre (JRC) report provides an overview of tools, practices, and programs across European, US, and Australian institutions (Ferguson, et al., 2016). Among a series of case studies, the report presents both the Open University's institutional policy for the ethical use of student data, as well as the University of Technology, Sydney's establishment of a dedicated institute for managing data to support decision-making across stakeholders. In its final assessment, the authors determine that while these and other case studies offer useful examples, they nonetheless come from a wide range of educational contexts. Consequently, the JRC authors determine that Europe needs its own plan. This conclusion represents an enduring enthusiasm for learning analytics while recognizing a lack of portability of learning analytics projects across contexts.

Also recognizing this variability, a report from the Australian Government Office for Learning & Teaching summarizes learning analytics strategies for improving student retention across six different higher education institutions (Gaševic, et al., 2016). In their analysis of the various practices related to using learning analytics for the purpose of addressing student retention issues, the report arrives at seven main guidelines that detail the need to: 1) designate a whole-of-organization strategy; 2) ensure strategies and tools are compatible with existing institutional values/practices/systems; 3) develop a coherent data platform with adequate standards and governance; 4) ensure data are accessible, transparent, valid, and reliable; 5) create actionable tools with an evidential base; 6) set appropriate conditions for educator adoption; and 7) support student empowerment. With attention to the role of and impacts on various stakeholders, these guidelines explicitly identify both students and educators and their unique relationships to learning analytics data and tools throughout the development and implementation process.

Competing Models and Frameworks

The Australian Government guidelines are representative of similar frameworks that learning analytics researchers have offered over the last two decades, many of which Colvin, et al. (2017) outline in their review of "Models of Learning Analytics Deployment." These models are organized into three categories: Inputs, Outputs, and Process.

Learning analytics Inputs models consider the "antecedents," or institutional and other requirements, for implementing learning analytics. Drachsler & Greller (2012) offer one of the earliest Inputs models, identifying six critical areas: 1) competences, 2) constraints (e.g., privacy/ethics), 3) technologies, 4) education data, 5) objectives, and 6) stakeholders. Arnold, et al. (2014) build on these categories, introducing macro-level terms related to "organizational capacity" according to four main categories: 1) technology infrastructure, analytics tools, and applications; 2) policies, processes, practices, and workflows; 3) values and skills; and 4) culture and behavior. With material concerns like technology and tools on one side, and human-centered concerns like culture and behavior on the other, these categories speak to the significance of institutional context, on a variety of levels, on how learning analytics might be implemented effectively.

Other notable Inputs models includes the EDUCAUSE Centre for Analysis and Research (ECAR) model, which accounts for six "dimensions" of institutional activity including: 1) decision-making culture, 2) policies, 3) data efficacy, 4) investment and resources, 5) technical infrastructure, and 6) institutional research (EDUCAUSE, 2016). Finally, Jones (2015) presents a similar framework including the categories: 1) institutional context, 2) impetus, 3) input, 4) interrogation, 5) intervention, and 6) impact. These various Inputs models are attentive to multiple layers of stakeholders, including both who those will be driving learning analytics at institutions and those who will be influenced or impacted.

In contrast to these Inputs models of learning analytics implementation are Outputs models that focus on the generation of learning analytics, envisioning that an institution's capabilities will evolve and mature over time. Colvin, et al. (2017) cite two outputs models, Davenport & Harris's (2007) "Analytics Framework," and Siemens, et al.'s (2013) "Learning Analytics Sophistication Model." At an early stage in learning analytics capacity, for example, an institution might produce log data and summary reports. At a later stage, an institution might produce forecasting and predictive modeling. Again, these models focus more on the evolution of data processing over time, and what applications these data might serve at different stages in this evolution.

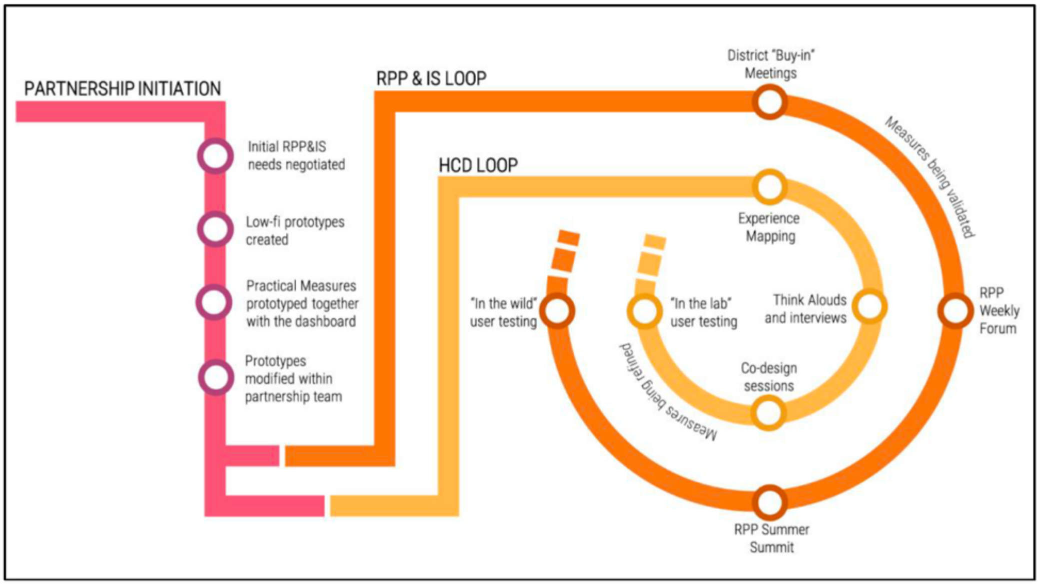
Finally, Process models break down implementation into a series of steps. In Adejo & Connolly's (2017) five-phase model summarized in ***Table 1*,** the process is sequential. As a rare example of a learning analytics implementation framework being directly applied to a real-world process, Drlík (2018) uses the case study of a single higher education institution and directly applies the Adejo & Connolly model. With its monitoring and control phase, this model tracks student performance, retention, and graduation.

Table 1. Adejo & Connolly (2017) LAI Model

Phase 1: Preliminary • Develop strategies for knowledge acquisition and accumulation about LA, data sources, and databases available.
Phase 2: Security Privacy and Compliance • Create benchmarks, guidelines, policies and standards for privacy, data protection, security, ethical use of data, and other legal compliance.
Phase 3: Roadmap Development • Analyze technological factors, organizational factors, and human-environmental factors.
Phase 4: Adoption and Evaluation • Test functionality, usability, performance, and supportability. • Assess risk, barriers, and limitation to implementation.
Phase 5: Monitoring and Control • Measure tool performance against performance benchmarks, student performance, security strategies, the rate of retention, and graduation. • Install system that monitors the performance and integrates application.

In contrast to this sequential process model, Ahn, et al. (2019) present an iterative process with the example of the development of the Edsight dashboard based on human-centered design (HCD) methods, research-practice partnerships (RPPs), and improvement science (IS). As seen in ***Figure 3***, the development process starts by initiating the partnership between researchers, designers and practitioners; then moves onto prototype development; followed by a cyclical process that further develops the dashboard based on user experience and preference while ensuring buy-in from a range of stakeholders.

***Figure 3*.** Ahn, et al., (2019) HCD/RPP/IS Model



The most significant Process model, cited throughout learning analytics literature, is the RAPID Outcomes Mapping Approach (ROMA). In many ways congruent with the Australian Government's recommendations presented earlier (Gašević, et al., 2016), the ROMA model takes important institutional inputs but presents them in a designated sequence. Ferguson, et al. (2014) summarize the ROMA model with the following seven steps:

1. Define a clear set of overarching policy objectives
2. Map the context
3. Identify the key stakeholders
4. Identify learning analytics purposes
5. Develop a strategy
6. Analyze capacity; develop human resources
7. Develop a monitoring and learning system (evaluation) (p. 128).

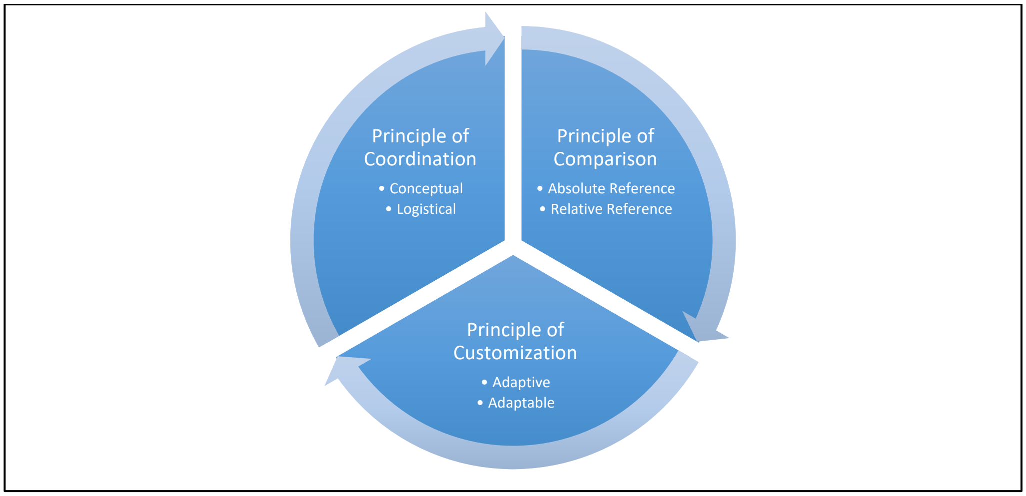
The ROMA model has been further refined with the development of the SHEILA framework, or Supporting Higher Education to Integrate Learning Analytics (Tsai, et al., 2018). SHEILA expands the ROMA model, providing a list of more specific challenges that might be encountered, and actions to take, at each step. For example, when identifying key stakeholders, ethics and privacy issues are the most significant challenges to overcome.

Drachsler & Greller (2012) also address ethics and privacy issues in their category of “constraints,” as mentioned, while Zhong (2015) categorizes ethics and privacy according to “digital citizenship.” Cited in many of the studies already referenced, the most significant contribution to ethics and privacy issues related to learning analytics comes from Slade & Prinsloo (2013). At the center of their inquiry is the power imbalance implicit to educators having access to student learning data. In response to a range of ethical issues encountered at each stage of the learning analytics data lifecycle – from misusing and misinterpreting data to unsafely storing it – the authors present “Principles for an Ethical Framework.” While this framework acknowledges the delicacy, and limitations, of using student data, it also recognizes the absolute necessity of learning analytics. Despite the potential pitfalls, the authors argue that institutions must leverage student data to improve outcomes.

Wise & Vytasek LAI Model

Building on this range of models and frameworks for introducing learning analytics into a variety of educational contexts, the Wise & Vytasek (2017) learning analytics implementation (LAI) model first appeared in the *Handbook of Learning Analytics*, published by SoLAR. I focus on this particular model as a way of exploring in more detail the sorts of contextual and other issues referenced in the other models already presented. In short, Wise & Vytasek argue that LAI should be examined using three guiding principles: Coordination, Comparison, and Customization. As summarized in the visualization provided in ***Figure 4***, each principle is further organized into additional components, discussed below.

Figure 4. Wise & Vytasek (2017) Learning Analytics Implementation (LAI) model



By Coordination, Wise & Vytasek mean that "the use of learning analytics needs to be conceived of as a central element of the learning design so that it is clear to the user how the analytics are meant to play a role in their regular engagement in the learning process" (p. 153). This principle seems to respond to criticism of learning analytics tools that are created outside of a specific learning context, and is representative of step 1 of the Australian Government's recommendation ("designate a whole-of-organization strategy") and steps 1 and 4 of the ROMA model ("define a clear set of overarching policy objectives" and "identify learning analytics purposes," respectively). Wise & Vytasek further divide the Coordination principle into both "Conceptual" and "Logistical." Conceptual refers to the need to start the design process by determining what of the available analytics to focus on, and clearly defining what the metrics are meant to represent. Logistical Coordination, on the other hand, refers to determining when learning analytics users should have access to the data. This planning ensures that relevant support can be provided so that users integrate the tool into their regular learning, teaching, and administrative practices.

The Principle of Comparison captures “the need for one or more appropriate reference frames with which to evaluate the meaning of an analytic” (p. 153). Wise & Vysatek describe Comparison reference frames as either “Absolute” or “Relative.” Absolute reference frames designate a fixed standard, determined in advance, to which the learning analytics can be compared, while Relative reference frames recognize standards that may change over time, often dependent on the type of learning activity. At face value, this level of nuance related to actually understanding how any particular learning analytics might be understood does not seem well explored among the other models considered so far. In its Preliminary stage, the Adejo & Connolly (2017) model does mention the need to develop strategies for knowledge acquisition and accumulation about learning analytics and relevant data sources, and the EDUCAUSE (2016) model describes its dimension of data efficacy as “relating to quality, standardization, ‘rightness’ of data and reports” (p. 22). Surely these other models implicitly understand the need to consider the meaning of the analytics themselves but do not directly discuss this part of the process.

Finally, the Principle of Customization recognizes “that there are multiple, disparate, and equally valid needs and paths (and potentially endpoints) for different learning analytics users” (p. 153). Within customization, Wise & Vytasek present “Adaptive” learning analytics, which are computationally rather than user-driven, and “Adaptable” learning analytics, which allow for different types of use according to the preferences or goals of the intended users. With its concern for context and stakeholder input, the Wise & Vytasek model focuses primarily on adaptable learning analytics.

This vision of “Adaptable” learning analytics returns us to Dawson, et al.’s (2018) consideration of “emergent innovators” of learning analytics. Evidently, Wise & Vytasek have in mind a context-specific, intentionally adaptable learning analytics implementation, perhaps with the idea that an institution or system would introduce learning analytics tools that could be tailored to the particular needs of different users. This intentionality at the institutional level seems decidedly different than Dawson et al.'s emergent innovators, who are implementing a range of learning analytics tools for a range of reasons, all of this activity likely happening beyond any system-level plan. Therefore, to escape the confines of learning analytics implementations models, even those like Wise & Vytasek's which advocates for adaptability, I now move on to complexity science.

Complexity Science

Complexity science is an interdisciplinary field, founded on the premise that many real-world systems, such as ecosystems, economies, and social networks, display complex and often unpredictable behaviors that cannot be fully explained by traditional reductionist approaches (Tetenbaum, 1998). In turn, complexity science seeks to better understand how different systems function by examining the interactions between their individual components. To further my research in complexity science, in the following section I start by providing a brief history of the field, built out of chaos theory and the foundation of the Santa Fe Institute. Next, I introduce the construct of complex adaptive systems (CAS), especially as it has been applied to institutions of higher education, followed by further discussion on the concept of emergence.

Chaos Theory and the Santa Fe Institute (SFI)

Perhaps the most important influence on the development of complexity science is chaos theory. As one of the earliest theorists in this field, in the 1960s, the meteorologist

Edward Lorenz discovered that small changes to a simple weather model could lead to vastly different outcomes, describing this phenomenon as the “butterfly effect,” and showed that it had important implications for weather forecasting and other fields (Lorenz, 2000). Later, the physicist Mitchell Feigenbaum (1978) discovered that the transition to chaos in certain systems occurs at a universal rate, regardless of the unique elements of the system. Subsequently, chaos theory has been used to study fluid flows, electrical circuits, and chemical reactions. Later applied to the social sciences, these findings have had important implications for our understanding of complex systems, challenging Newtonian views of the world that hold that any system’s behavior can be predicted simply by knowing the initial conditions and the supposed laws governing that system (Tetenbaum, 1998).

With a goal of studying complex systems using a multidisciplinary approach, the Santa Fe Institute (SFI) was founded in 1984 and has joined researchers from a wide range of disciplines, including physics, mathematics, computer science, biology, and economics (Baker, 2022). Started primarily by scientists from the Los Alamos National Laboratory – famous for its work on developing nuclear weapons during World War II – the SFI has played an essential role in promoting complexity science research and education, and has served as a center for many influential scholars in the field. Notable work from the SFI include *The Economy as an Evolving Complex System*, the proceedings from a workshop that assembled economists, physicists, and computer scientists to explore the application of complex systems theory to economics (Arthur, et al., 1997). In *The Origins of Order* (1993), Stuart Kaufmann argues that complexity arises from an exchange between order and randomness, and contributes to our understanding of the origins of life and the evolution of complex systems. Finally, *The Structure and Dynamics of Networks* has been integral in shaping the field of network science (Newman, et al., 2006). From these various major and other works, complex adaptive systems (CAS) have proven to be one of the field's most enduring constructs, especially as it has been adopted throughout the social sciences for the study of organizations, processes, and other entities across disciplines.

Complex Adaptive Systems (CAS)

Naturally occurring CAS such as ecosystems, the human brain, and the immune system exhibit adaptive behaviors that emerge from the interactions of many individual components. One of the standard examples are ant colonies, with the seemingly inexplicable actions and interactions of individual ants somehow coalescing into the coherent project of building the colony. Today, the CAS construct is studied and applied across a wide range of disciplines, including physics, biology, economics, computer science, and the social sciences.

Grounded in Holland's (1995) foundational exploration of the concept, CAS can be described as being composed of diverse agents that interact with each other and their environment, resulting in emergent global behavior patterns. Delving deeper into what this agent interaction entails, Carmichael & Hadžikadić (2019) focus on feedback, self-organization, and non-linear behavior. In short, feedback considers how "as the agents in a complex system interact, the results of some interactions may influence future interactions" (Carmichael & Hadžikadić, p. 10). Self-organization can relate to how individual agents, "by providing feedback to other agents, and influencing them to act in similar ways" can influence "the organization of the overall system" (Carmichael & Hadžikadić, p. 13). This property of self-organization in particular contributes to, and overlaps with, the concept of emergence, or emergent behaviors and patterns, which will be explored in more detail in the following section. Altogether, these features contribute to the non-linear nature of change in systems, which can happen quickly and erratically, "ensuring that the future of these systems are often unknown and challenging" (Carmichael & Hadžikadić, p. 2).

Much of CAS research from the 1990s and early 2000s focused on computational models of adaptive agents. For example, Miller & Page's (2007) succinct description of the modeling process goes as follows:

> We assume that the real world consists of various states, *S*, and a transition function *F* (*S*) that maps a given state at time *t* into a new state at time *t* + 1. The function *F* (*S*) is unknown to the modeler, and while the modeler would like to uncover *F* (*S*), this will typically be impossible given the dimensionality of the state space and potential complexity of *F* (*S*) (pp. 38-39).

By introducing agents into the modeling techniques, Miller & Page (2007) provide examples of exploring such complex social systems and processes as segregation, city formation, and, interestingly, deciding to go to the beach on the weekends. Among a variety of research related to complex social systems, Desouza & Lin (2011) advocate the use of computational models as an evidence-based approach to designing public policy. Representative of the wide application of CAS to the healthcare system, Gomersall (2018) offers an agent-based model (ABM) focused on changing health behaviors.

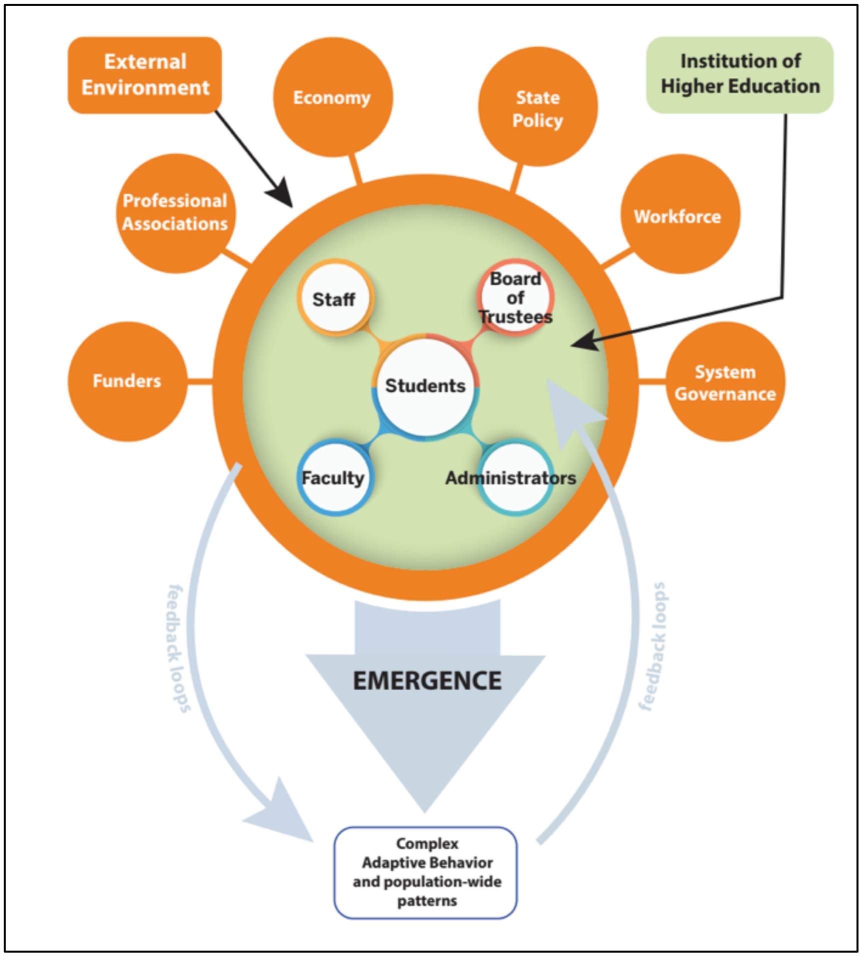
As complexity science has extended to the social sciences, numerous researchers have moved beyond computational modeling, instead using the properties of CAS as a way to describe and attempt to better understand a variety of aspects across different fields including education. For example, Burns & Knox (2011) use CAS theory to argue that linear, categorical descriptions of classroom processes and interactions do not adequately explain the complex nature of classrooms. Building on a qualitative study of classroom observations and teacher interviews, the authors conclude that "classrooms are convergences that reach backwards and forwards temporally, discursively, socially, cognitively, and culturally" (p.19). Focused specifically on small-group problem-based learning (PBL), Mennin (2007) confronts the narrow, simplistic approach of previous PBL studies, determining that "future curriculum designs and research studies that recognize small-group PBL as a complex adaptive system and focus more on the dynamics of learning as a self-organizing event emerging from interactions among multiple factors are more likely to shed light on how and why PBL is or is not effective" (p. 311).

Similarly interested in the non-linear nature of learning in the classroom, Wang, et al. (2015) offer the "Complex Adaptive Blended Learning System" (CABL), which attempts to map the dynamic relationships among what the researchers identify as the six different subsystems of blended learning: learner, teacher, learning support, content, technology, and institution. Based on their review of blended learning literature and using the language of CAS, the authors conclude that blended learning is complex, adaptive, dynamic, self-organizing, and co-evolving.

Going even further, McGee & Edson (2014) apply a CAS framework to the entire U.S. public education system. In particular, the authors focus on the challenge of managing the wide range of "interacting, intelligent and independent actors" including "Local/State/Federal governments, school administrators, teachers, students and parents (p. 132). This multitude of actors, and their multitude of interactions, directly influence both learning itself, as well as how actors including teachers and administrators achieve goals. Likewise, Fidan & Balcı's (2017) conceptual study depicts schools as constantly changing complex systems, and that administrators must be able to enact flexible management structures and promote innovation to contend with this change. Based on their systematic analysis of two urban schools utilizing both classroom observation and interviews with teachers and school administrators, Kershner & McQuillan (2016) would agree. Through the lens of CAS, the authors promote a new approach to school leadership based on "the need to disrupt the status quo as a precursor to adaptive change, the power generated by distributing authority through decentralized networks, the importance of relational trust, and the impact of school culture" (Kershner & McQuillan, p. 22).

Numerous researchers have applied the language of CAS specifically to higher education. As seen in ***Figure 5***, Martin (2019) provides a visual model of higher education institutions according to CAS principles. In this model, institutions are "made of diverse, active, interdependent agents (students, staff, faculty, and administrators) interacting and adapting on the basis of knowledge, experience, feedback from the environment, local values, and formal system rules" (p. 59).

Figure 5. Martin (2019) Higher Education CAS model



For most researchers, using a CAS framework to capture the complexity of higher education institutions is a way of calling for new leadership approaches, especially in terms of how to promote and enact change. Martin provides the specific example of Mathematics pathways, describing how "the lack of coordination and coherence of mathematics course requirements across institutions presents challenges for students, advisors, and faculty when helping students enroll in courses that meet their need as transfer students" (p. 62). Consequently, Martin highlights the need for institutional leadership to embrace some of the defining characteristics of CAS, namely, that leaders should create conditions for stakeholders to self-organize while creating meaningful feedback loops to encourage the development of new ideas. This argument mirrors Priyadarshini & Abhilash's (2022) study of how best to promote and implement United Nations Sustainable Development Goals. Fearing that traditional models will not meaningfully impact sustainability development education, the authors hold that higher education institutions must utilize their "high diversity, multiple interaction pathways and several stakeholder groups" and adopt CAS principles in order to "evolve, adapt and innovate" (p. 4).

Providing perhaps the most ambitious and exhaustive application of CAS to higher education institutions, Ueland, et al. (2022) present Minnesota State's effort, called Equity 2030, to eliminate educational equity gaps throughout all colleges and universities throughout the Minnesota system. The authors argue that such a transformation depends on embracing CAS approaches, which includes leveraging "strategically constructed chaotic elements" and "building from niche or experimental programming that may already be occurring at the grassroots [to] provide pathways that may ultimately be more natural for system evolution" (p. 136). As summarized in ***Table 2***," the authors map out a conceptual framework of CAS characteristics paired with examples from US higher education.

Table 2. Ueland, et al. (2021) CAS Higher Education Framework.

CAS Characteristic	Higher Education Feature
Networks	faculty groups, senior leadership teams, professional communities, student/faculty interactions
Non-Linearity	strengths and weaknesses of large-scale versus localized initiatives
Self-organization	committee structures throughout the system, self-governance
Feedback loops	range of formal and informal meetings relating to formal and informal structures
Path dependency	constraints, such as established hierarchical channels of communication, and general campus culture
Co-evolution	interactions of systems, and systems within systems, that promote change throughout
Emergence	pilot programs, campus-based initiatives, experimental sites
Attractor	a state from which activity and outcomes are drawn

Emergence

As seen among the various definitions and studies already presented, "emergence" is central to understanding CAS. Just as there are a range of definitions for CAS, emergence, too, has also been described in many ways. In an attempt to synthesize the main commonalities among competing definitions, Fulmer & Ostroff (2015) provide the following description, which focuses on identifying the various parts of a system and the interactions between those parts:

> First, emergent processes create a higher-level "whole" that is formed from the individual "parts" in the system. Second, some degree of interaction among the individual elements occurs, which fosters a convergence. Third, it is the interaction among the individual elements that allows a new pattern or form to emerge as a collective, higher-level phenomenon. Finally, emergence is a dynamic process that occurs over time (p. 123).

A primary debate concerning emergence is whether or not the individual agents, elements and other ground-level features of CAS, can be adequately studied to provide insight into the emergent phenomenon. Accordingly, researchers often differentiate between strong and weak emergence. Strong emergence, or emergence considered from a "holistic" perspective, contends that "micro-level activities are woven together in such a complex and sometimes unobservable way that the novel emergent whole has no simple decomposable explanation or cannot be sufficiently predicted from knowledge of the parts" (Fulmer & Ostroff, 2015, p. 125). In contrast, for weak emergence, or emergence from a reductionist perspective, "the properties of the whole can be explained from micro-level activities by examining their parts and interactions" (p. 125).

Within CAS, there is usually not a single, global entity or directive that is facilitating a certain emergent property to occur. Instead, there are a diverse collection of elements, occurring and aggregating at different levels throughout the system. Most importantly, there are a multitude of agents, and a multitude of interactions among these agents, and among the agents and the various elements, altogether creating a complex social structure. According to Morgeson and Hofmann (1999), "the structure of an emergent property is viewed as series of ongoings (individual actions constrained by context), events (discrete interactions between individuals through action–reaction behavior or communication), and event cycles (continued patterns of interactions and action–reaction behavior)" (qtd. in Fulmer & Ostroff, 2015, p. 126-127). As an example pulled from the field of organizational psychology, Ruef (2000) describes the various historical, technological, policy, and other related elements that led, over time, to the emergence of unique organizational forms within the American healthcare sector. Typical of this field, Ruef uses a quantitative approach, developing a model based on decades worth of data to show how a confluence of certain characteristics led to current health care organizational structures. Powell & Sandholtz (2012) also study the emergence of unique organizational forms, in this case focusing on the first biotechnology companies, using hierarchical cluster analysis based on variables pulled from a nearly a decade's worth of sources including published interviews and newspaper articles.

The multitude of interactions between agents, and between agents and other elements, are representative of social construction largely dependent on sensemaking, which "involves systematic processing of information and signals in the organizational environment in an effort to interpret and derive meaning from them" (Fulmer & Ostroff, 2015, p. 126). Undoubtedly, sensemaking is its own field of study, explored across many different disciplines, including education research. For example, in their consideration of school leadership and educational reform, Ganon-Shilon & Schechter (2017) describe sensemaking as "an active process of constructing meaning from present stimuli, mediated by prior knowledge, experiences, beliefs and values that is embedded in the social context within which people work" (p. 684). In short, sensemaking can be considered one of the important processes by which different agents within a CAS take all of the information and interactions, and, both individually and collectively, create a dynamic social context that give rise to emergent phenomena.

Building on the previous examples of CAS research, emergence is referenced throughout higher education literature, specifically as it relates to challenging, and determining alternatives to, traditional forms of research and practice. For example, in an analysis of the concept of "teaching excellence" in higher education, Wood (2017) argues that rather than being a set of standards that can be easily identified and assessed, "it is the wide range of knowledge, skills, values and contexts inherent in the pedagogic environment, which lead to the growth of teachers' emergent practice" (pp. 61-62). In the same ways that

Burns & Knox (2011) and Mennin (2007) argue that classrooms themselves are CAS resulting from diverse elements rather than some single, hierarchically-imposed structure, Wood suggests that from these complex systems emerge ever-changing pedagogies, including what might be considered "teaching excellence," the terms of which cannot be easily identified from a static, institutional framework.

Similarly concerned with the need for ground-level interrogation into the realities of teaching and learning, Doyle & Brady (2018) argue against traditional higher education theories of change that focus on top-down processes that assume institutions, at their highest levels of leadership, are capable of identifying end goals as well as envisioning, implementing, and monitoring the progress towards achieving those goals. Within this traditional paradigm, change analysis focuses on the transition process from start to finish, on identifying obstacles to success, and describing what should, by design, be happening. Arguably, this description closely echoes many of the Inputs and Process-based learning implementation models.

As an alternative, Doyle & Brady (2018) emphasize that leaders must examine "what is actually happening in institutions" (p. 6). According to what the authors refer to as an emergent paradigm, "the analysis of change in higher education shifts to an internal, micro, perspective. Attention is directed to the daily work of the institution and the detail of how academics and others respond to the contextual demands placed on them resulting in outcomes that may sometimes lead to transformational change at institutional level" (p. 6). This attention to the internal, the micro, is the same call from Dawson, et. al (2018), who, in their recognition of "emergent innovators," recognize that the "organizational level of analytics adoption is not so well understood. One approach to better understand this space is to draw on analyses of social capital and organizational network structures" (p. 243). That is, we must go to the source, to the level of agents and their individual contexts, to see what, how, and why things are happening. From these insights we might then be able to determine a pathway forward for fuller institutional learning analytics adoption and expansion.

With this research project, I have attempted to directly address these issues that both Doyle & Brady (2018) and Dawson, et. al (2018) raise. With my first research question - *What types of learning analytics do these stakeholders employ, and for what purposes?* – I sought to identify what sorts of learning analytics-related tools and practices were being used among stakeholders that Dawson, et al. (2018) might consider "emergent innovators." As described, the literature focuses significantly on the proliferation of learning management systems (LMS) and the preponderance of learning analytics dashboards (LADs) with a range of intended users and functionality. In my consideration of stakeholders from multiple academic units at a single higher education institution, my first goal was to establish what tools and approaches these stakeholders were actually using and for what purposes.

My second research question – *What are stakeholders' teaching and learning backgrounds and experiences, and to what teaching and learning related resources do they have access?* – is a direct response to Dawson, et al.'s (2018) call "to draw on analyses of social capital and organizational network structures" (p. 243). Accordingly, my goal was to uncover the interactions, resources, networks, personal and professional backgrounds and experiences that contribute to how and why stakeholders at one institution are implementing learning analytics-related tools and approaches in the ways they describe. My premise was that learning analytics tools and approaches do not exist within a vacuum, and how stakeholders arrive at using any particular tool or approach is the result of a range of influences.

My third research question – *How might institutions leverage and support current learning analytics structures and practices* – was designed to draw on my findings from the previous two questions, mirroring Doyle & Brady's (2018) focus on "the daily work of the institution and the detail of how academics and others respond to the contextual demands placed on them resulting in outcomes that may sometimes lead to transformational change at institutional level" (p. 6). Considering the nature of change within a complex adaptive system (CAS), my goal was to arrive at recommendations grounded in the highly specific contextual elements of the stakeholders and their respective academic units at a single institution.

Cumulatively, I wanted this research project to provide a granular depiction of "what is actually happening in institutions" (Doyle & Brady, 2018, p. 6). Most if not all researchers interested in learning analytics implementation will agree that context is key. Recognizing the importance of context is easy. The challenging part is actually analyzing contexts in order to determine a path forward. Thus, I hope this research project serves as a model for how others might investigate similar institutions and determine ways to promote the expansion of learning analytics to further enhance teaching and learning.

Chapter 3: Methodology

I designed this research project as an embedded case study, which Scholz and Tietje (2002) describe as including "more than one unit, or object, of analysis…The multiplicity of evidence is investigated at least partly in subunits, which focus on different aspects of the case" (pp. 9-10). Given my complexity science-informed consideration of higher education institutions, an embedded case study reflected my intent to engage with multiple stakeholders across multiple academic units within a single institution.

Among the variety of learning analytics research presented so far, studies might be organized into the three following general categories: 1) the description of the development and/or function of a particular learning analytics tool; 2) the description and/or assessment of learning analytics implementation at the individual classroom, institutional or system level; and 3) the offering of prescriptive models, frameworks, and other guidance on how learning analytics should be implemented.

This project differs from these approaches in some fundamental ways. First, while I investigated stakeholders and academic units within a single higher education institution, I did not seek to investigate the use of a particular learning analytics tool. While participants, all belonging to the same general institutional context, had access to some or all of the same tools, the premise of my research was that they were not each using all of them, or using them in the same way, or using them for the same purposes. Thus, one of my goals was to discover what tools these participants were using and for what purposes.

Second, I did not seek to somehow quantify the impact of the learning analytics tools or approaches on teaching, learning, or anything else. While I hoped to better understand the different ways stakeholders described the effectiveness or overall impact of their learning analytics usage, my purpose was to uncover the unique contextual circumstances that explained how and why participants were using certain tools or employing certain practices. Instead of working with participants who are currently part of a research study relating to the development of a new learning analytics tool, or formally assessing the outcomes of a learning analytics implementation process, my research was committed to describing the contexts in which participants across academic units were attempting to do their jobs, in part through the aid of learning analytics, whatever that meant to them.

Third, by grounding my research in complexity science, I wanted to offer recommendations that went beyond the various Inputs, Outputs and Process models already available. By focusing on the conditions and other factors that have led to current practices, my goal was to uncover what was already happening and how current structures, resources, and practices might be further encouraged, improved, and, potentially, expanded.

Scholz and Tietje (2002) affirm that "[c]ase studies may be both descriptive and explanatory," and, therefore, "are often used as a pragmatic research tool in order to understand thoroughly the complexity of a given problem and to support decision making" (p. 5). Accordingly, my first and second research questions were designed to describe the learning analytics contexts, personal backgrounds and access to teaching and learning resources among a variety of stakeholders within a single higher education institution, and my third research question was designed to lead to recommendations, based, in part, on those previous findings.

Learning analytics tools are already widely available and being used for a range of purposes, usually beyond the confines of formal research studies or institutional mandates and directives. In order to achieve the more flexible, distributed, and innovative leadership models that other researchers grounded in complexity science have called for, we must first seek a better understanding of what practitioners are doing on the ground now. Consequently, my goal was to arrive at recommendations that focus on investing in, strengthening, and otherwise supporting the various structures and practices that have already emerged. By design, this endeavor was extremely sensitive to local educational contexts, with the understanding that any learning analytics strategy within a complex higher education institution must not only accept but also promote a diversity of outcomes.

Context

The context of this study was a large, public, R1 research institution, in the Eastern part of the United States, with an undergraduate enrollment of nearly 30,000 students and a graduate enrollment of nearly 10,000 students. With more than a dozen colleges and schools, and more than 100 undergraduate degree program, the university employs several thousand faculty members.

University-level resources related to teaching and learning with technology, and with data and research, include a Division of Informational Technology, a Teaching and Learning Center, an Office of Institutional Research, and half a dozen on-campus libraries. The university provides the learning management system (LMS) Canvas, from the company Instructure, which is available to all faculty and students.

Throughout the many colleges and schools, and many more departments and centers across campus, there are a multitude of structures, roles, and hierarchies focused on supporting, managing, and assessing students and faculty. Departments vary in size, with different organizational structures and personnel, in addition to varying access to resources.

Having reviewed a range of learning analytics tools and initiatives, across individual classrooms, schools, institutions, and educational systems, my research focused uniquely on undergraduate teaching and learning. In addition to academic units, this institution also consists of many different offices, centers, and other entities offering a range of services catering to students, faculty, and others (e.g., Student Housing, Health Center, Athletics, Dining, to name a few). These other entities and their various stakeholders likely have their own interests in accessing and leveraging available student data in relation to their particular contributions to the overall educational endeavor. While these various entities might also participate in what might be considered learning analytics activities, especially at the university-level, my research project was limited to teaching, learning, and the support/management thereof, specifically as it related to undergraduate education at this single higher education institution.

Participants

With a focus on undergraduate teaching and learning, and building on higher education and complexity science literatures, I started with the premise that higher education institutions are, often, significantly heterogenous, composed of many different actors, many different systems, and systems within systems, resulting in a range of interactions. Accordingly, within this single higher education institution, I sought out stakeholders from multiple academic units, across disciplines, whose teaching and other responsibilities focused primarily on undergraduate education. Recognizing the multitude of perspectives and experiences among different types of stakeholders, I intentionally sought faculty, administration, and support staff from each of these academic units.

As the preliminary stage of my research, I reached out by email to faculty, administrators, and support staff in a range of academic units, in addition to representatives of some relevant university-level offices. My goals were: 1) to gain further insight into this higher education institution, and 2) to identify academic units where there seemed to be interest in discussing teaching and learning in general, and learning analytics specifically.

During this preliminary stage, I was able to speak with both an Assistant Vice President from the Teaching and Learning Center as well as an Associate Dean with responsibilities related to General Education for the institution. Through these initial informal discussions, I was able to confirm that there has been some noted interest from a variety of stakeholders across the university into the potential of learning analytics solutions, as well as some resources invested in enterprise-level analysis of the Canvas LMS and other tools.

During this preliminary stage, I was also able to speak to stakeholders from three different academic units. From these initial conversations, I learned that these individuals, and related faculty and leadership from their academic units, had at least some familiarity with learning analytics and participated in teaching and assessment practices that could be relevant to my research. For example, each of these stakeholders described their use of the Canvas LMS for both teaching and administration purposes, relying on a range of data sources for course design, assessment, and other activities.

Having established these relationships, and upon receiving IRB approval, I then reached out to these individuals again, also asking them for recommendations and introductions to others in their academic units and other, related academic units. I interviewed a total of 16 participants, representing staff and faculty, with a wide range of leadership and support roles, from across the institution. To ensure anonymity, I have excluded participant names and have altered the names of some academic units.

In the highest university-level positions, I was able to interview both an Executive Director and an Associate Director from the institution's Teaching and Learning Center. From the College of Math & Sciences, I was able to interview an Assistant Dean, an Associate Chair, a Course Coordinator, and both tenure track and non-tenure track faculty.

From the College of Information Sciences, I interviewed a Co-Director of one of the undergraduate degree programs, in addition to both tenure and non-tenure track faculty. From the Department of Communication, including a Co-Director of a GenEd program, as well as two Non-Tenure Track participants who teach sections of the same course in this GenEd Program. Finally, I was able to interview two instructional designers from the College of Business. A summary of all participants is provided in ***Table 3***.

Table 3. Participant Summary

Participant	**Center/College/School**	**Department**	**Faculty Track**	**Leadership/Support Role(s)**
P1	Teaching and Learning Center			Executive Director
P2	Teaching and Learning Center			Associate Director
P3	Math & Sciences	Biology	Non-Tenure Track	Assistant Dean, Director
P4	Math & Sciences	Math	Tenure Track	Associate Chair
P5	Math & Sciences	Math	Non-Tenure Track	Course Coordinator
P6	Math & Sciences	Math	Non-Tenure Track	
P7	Information Sciences		Tenure Track	Co-Director
P8	Information Sciences		Tenure Track	
P9	Information Sciences		Non-Tenure Track	
P10	Information Sciences		Non-Tenure Track	
P11	Arts & Humanities	Communication	Tenure Track	Co-Director
P12	Arts & Humanities	Communication	Non-Tenure Track	Assistant to the Chair
P13	Arts & Humanities	Communication	Non-Tenure Track	
P14	Arts & Humanities	Communication	Non-Tenure Track	
P15	Business			Program Manager, Instructional Designer
P16	Business			Instructional Designer

In addition to these participants, I also attempted to connect with Dean- and/or Director-level representatives from the College of Arts & Humanities, but my contacts stated they did not feel comfortable going on the record for this study. Moreover, from the College of Business, in an effort to complement the interviews I had with the two instructional designers, I sought out numerous faculty members, program directors and other support staff. Unfortunately, I did not receive responses to my inquiries.

Data Collection

Following the examples of other CAS studies, especially those focused on higher education institutions, as well as many learning analytics implementation studies, I conducted semi-structured interviews to collect data for this qualitative research project. As Brinkmann (2014) describes, semi-structured interviews "can make better use of knowledge-producing potentials of dialogues by allowing much more leeway for following up on whatever angles are deemed important by the interviewee; as well, the interviewer has a greater chance of becoming visible as a knowledge-producing participant in the process itself" (p. 286). My project focused on capturing the variety of contexts and stories of learning analytics from a range of perspectives; consequently, the semi-structured format allowed me to engage with participants in a way most conducive to uncovering the nuance of participant experiences.

Following IRB approval, all semi-structured interviews were conducted 1-on-1 over Zoom and were recorded with participant permission. All interviews were conducted between October and December 2023, with each interview lasting approximately 30 minutes to an hour. At the beginning of each interview, I asked participants to provide a brief introduction of themselves, to provide their educational and professional backgrounds, as well as their current roles and responsibilities at this higher education institution. Again, since these were semi-structured interviews rather than a questionnaire or survey, participants provided different levels of information about various components of their backgrounds and current roles. An alternative, or additional, approach might have been to specifically account for total years of relevant experience, total years at this particular higher education institution, highest degree earned, and other specific details that might further categorize this group of participants beyond their current rank and academic unit, as already provided in ***Table 3***. However, I did not explicitly ask for these details, and not all respondents provided them.

As described in more detail in ***Appendix A***, I started each interview with a list of general questions, including:

- In your opinion, what is learning analytics, and what is its purpose?
- How did you first learn about learning analytics?
- When did you first decide to investigate learning analytics resources?
- Have you worked with anyone, or used any specific resources, to determine how you would use learning analytics?
- For what specific purposes have you used learning analytics solutions?
- What specific learning analytics tools do you use?
- Has your use of learning analytics been successful? How do you know?

As semi-structured interviews, not all conversations went in this exact order, with many participants feeling more comfortable or interested in discussing certain aspects of their backgrounds, teaching, and other experiences.

Considering the descriptive and explanatory goals of this project as captured in the three research questions, I was able to schedule my interviews with my thirteen academic unit participants before I met with my three College and Teaching and Learning Center participants. Thus, my interviews with academic unit participants served as the foundation for my interviews with the three College and Teaching and Learning Center participants, which, in turn, led to my recommendations.

Data Analysis: Theoretical Framework

To interpret the results of my semi-structured interviews, I started by drawing from two main bodies of research already presented: Learning Analytics and Complexity Science, namely the CAS construct and its attention to emergence. From the general learning analytics literature, I depended on Sergis & Sampson (2017), who categorized learning analytics for teachers. From the Complexity Science literature, I relied specifically on Ueland, et al.'s (2021) CAS framework for understanding higher education institutions.

As discussed, much of the concern for understanding agent behavior within a CAS such as a higher education institution relates to determining how these agents access knowledge and form ideas, with these processes related to both feedback loops and self-organizing practices, among others. Therefore, to complement the CAS framework, I also used Fives & Buehl's (2008) Teacher's Knowledge Framework, which identifies five knowledge types as they relate to examining teachers' beliefs regarding their own knowledge and ability. These knowledge types include: 1) pedagogical, 2) students, 3) content, 4) management/organizational, and 5) self/other. Using this framework was my attempt to attend to Ganon-Shilon & Schechter's (2017) concept of sensemaking as "an active process of constructing meaning from present stimuli, mediated by prior knowledge, experiences, beliefs and values that is embedded in the social context within which people work" (p. 684).

Data Analysis

As Yin (1994) warns, one major risk of embedded cases studies is when the study "focuses only on the subunit level and fails to return to the larger unit of analysis" (p. 45). Keeping this in mind, I structured my research questions and data analysis to capture meaningful attributes of, as well as similarities and differences between, my subunits – i.e., individual stakeholders and academic units – while also returning to analysis and recommendations that relate to the overall case of this single higher education institution.

I followed Creswell's (2014) process for qualitative research data analysis. Since all interviews were recorded, I started by transcribing responses and making preliminary notes regarding major themes and other insights. Next, I began the coding process, which included a combination of both predetermined and emerging codes. Predetermined codes appear in ***Appendix B*** and are based on the Learning Analytics, Teacher's Knowledge and CAS frameworks already discussed.

During the coding process, I also considered participant responses according to academic units. Because academic units at this higher education institution seem to exhibit independence in terms of teaching and administrative practices, and providing support to faculty and students, I found that learning analytics and related activities manifested in unique ways according to the structures and activities of academic units.

Overall Analysis

To answer my first research question – *What types of learning analytics do these stakeholders employ, and for what purposes?* – I considered findings from my interviews with the 13 academic unit participants. I consolidated my findings into two main sections, one focused on the specific learning analytics-related tools that participants mentioned using, and the other focused on the various purposes of learning analytics that participants identified. For each of these sections, I organized responses by academic unit and provided a summary in the form of a table. At the end of the chapter, I synthesized responses across participants, focusing on three main areas: Course Modality, Aggregate Data, and Learning Outcomes Assessment.

For my second research question – *What are stakeholders' teaching and learning backgrounds and experiences, and to what teaching and learning related resources do they have access?* – again, I considered findings from my interviews with the 13 academic unit participants. I consolidated my findings into two main sections, one focused on mapping participant responses onto the Teacher's Knowledge Framework, and the other focused on identifying the range of learning analytics-related resources that participants mentioned. For each of these sections, I organized responses by academic unit and provided a summary in the form of a table. At the end of the chapter, I synthesized responses across academic units, focusing on the issues of Collaboration and Canvas LMS and other Tools Training and Support.

For my third research question – *How might institutions leverage and support current learning analytics structures and practices?* – I focused on three specific areas identified in the earlier chapters: Canvas LMS and other Tools Training and Support, Aggregate Data, and

Learning Outcomes Assessment. I discussed these topics with three College and University leaders, gaining their perspectives in an effort to determine what work, if any, was already being done on these fronts, and what plans there might already be for the future. Building on Dawson, et al.'s (2018) consideration of "emergent innovators," my findings supported what might be considered a "bottom-up model of adoption…more associated with the developing alliances among independent units" (p. 243).

Based on these findings, in my Discussion section, I then applied Ueland et al.'s (2021) Higher Education CAS framework to arrive at recommendations on how this higher education might further expand its adoption of learning analytics-enhanced approaches to undergraduate teaching and learning. In contrast with many of the Inputs and other learning analytics implementation models that some researchers have offered – those which advocate top-down directives and centralized resource management – I instead focused on how this institution might invest in and further bolster the ground-level structures and practices that already exist.

Validity

Below, I consider potential researcher bias as well as overall limitations to this particular study.

Researcher Bias

Since 2009 I have been a faculty member in the English Department at the University of Maryland, College Park, promoted to the rank of Principal Lecturer in 2021. Within the English Department, I have also served in the role of Blended and Online Learning Coordinator since 2013, providing me with years of experience building and teaching courses as well as creating and managing a faculty training program. I am also a Canvas LMS administrator, meaning I have expert knowledge of this learning technology, as well as other related technologies, and I have served on a range of technology- and research-related initiatives across the English Department and the University. I have also participated in previous learning analytics research, attempting to investigate the overall design and effectiveness of courses I have developed. This background is the foundation for my interest in learning analytics in higher education.

While this background and experience enhances my credibility for engaging with faculty members and other stakeholders on these topics, it also means that I arrive at any interaction with my own related teaching and administrative practices. Hailing from an English Department, I also arrive with the particular values, disciplinary knowledge, and practices that are unique to that context.

Therefore, I approached each interaction with participants without the intent of comparing others' experiences and practices with my own. My findings, the interpretation of my findings, and the recommendations I offer, are based on my interactions with participants through data collection and analysis.

Study Limitations

By no means does this study provide an exhaustive investigation of this entire higher education institution. While I interviewed stakeholders from academic units that engage with large undergraduate student populations, this study is limited in that it represents neither all stakeholders from particular academic units nor all academic units. Furthermore, because my research was meant to showcase the highly variable, context-specific histories and processes that give rise to learning analytics usage within complex higher education institutions, the nature of such variability potentially limits how well some of my findings are representative of other similar academic units within the same institution or at other institutions.

As will become clear in the findings of this research, not all participants had a clear understanding of what learning analytics is or might be, and, in many cases, were uncertain whether or not the tools and approaches they were using to teach their courses or manage and support academic units would be considered representative of learning analytics. This uncertainty was apparent in some of my initial, informal conversations with stakeholders, and became even more apparent during my formal interviews that are captured in my results. While other embedded case studies often rely on a combination of both quantitative and qualitative approaches, including surveys, the semi-structured interview format of this study proved essential to eliciting nuanced responses from participants about their experiences and current practices.

For some readers, it might seem curious that student voices are excluded from this study. Numerous studies already referenced concern student experience in the design and use of learning analytics tools, and numerous studies have considered the thoughts, beliefs, preferences, and concerns of students and the use of learning analytics tools and data. Undoubtedly, learners themselves deserve the locus of attention. Nevertheless, this study is focused on how learning analytics might be used and implemented in higher education institutions, from the perspective of those most directly related to the implementation and assessment of these activities as it relates specifically to undergraduate teaching and learning. Within both the CAS framework for higher education as well as the Teacher's Knowledge Framework, interactions with students, as well as knowledge and perceptions of students, are important properties of stakeholders within complex higher education institutions. Therefore, while student voices are not included in this study, how other stakeholders think about students, and how they consider their interactions with students, was central to my project.

Chapter 4: *Research Question 1* Findings

What types of learning analytics do stakeholders employ, and for what purposes?

I derive my findings in this section from responses from the 13 academic unit participants. As described in ***Chapter 3***, these 13 participants provide the foundation for the descriptive elements of this embedded case study.

The goal for my first research question was to uncover the landscape of learning analytics practices across academic units at this higher education institution. I present my findings related to my first research question in the following order. First, I identify the specific learning analytics-related tools that participants mentioned using, organizing responses by academic unit. Building on this section, I then consider the specific purposes that participants mentioned using learning analytics, again organizing by academic unit. I end the chapter with a synthesis of responses across participants according to three main areas: Course Modality, Aggregate Data, and Learning Outcomes Assessment.

Learning Analytics Tools

In this section, I consider the specific learning analytics-related tools that participants mentioned using to accomplish the range of teaching, course management and other functions they described. Based on participant responses, I identified seven separate categories of tools, which I define below:

- **Canvas LMS-General:** This category includes the Canvas LMS for general teaching and/or course management practices such as hosting content, communicating with students, accepting submissions, and managing grades.

- **Canvas LMS-Quizzes:** This category includes the “Quizzes” functionality in the Canvas LMS, for diagnostic, assessment, or other purposes.

- **Canvas Analytics Dashboards:** This category includes the use of Learning Analytics dashboards within the Canvas LMS, for tracking student activity, learning outcomes, and other purposes.

- **Video:** This category includes video content, across various platforms, live and/or recorded, provided to students.

- **Other Submission Platform:** This category includes other platforms used to accept and manage student work, beyond the Canvas LMS.

- **Other Content Platform:** This category includes other platforms used to provide content to students, beyond the Canvas LMS.

- **Other Tools:** This category includes other tools, including surveys, used to gather information from students or track student activity and performance data outside of the Canvas LMS.
    - This category excludes university-issued course evaluations, which are automatically distributed to every student in every course at this higher education institution.

Math

In the context of Math, I found fairly general use of the **Canvas LMS** for communicating with students and storing content, with some use of **Canvas Quizzes** and the **Canvas Analytics Dashboards**. Participants were also using platforms beyond the Canvas LMS, and I found evidence of some potential approaches and materials being shared between the Course Coordinator and the relatively new faculty member. Participants also mentioned **Other Tools** and **Other Submission and Content Platforms**, though they mentioned pursuing these options with limited or no additional support, sometimes resulting in abandoning these tools.

The Associate Chair (P4) was the only participant from this academic unit to mention using the **Canvas Analytics** dashboard, primarily for the purpose of investigating student and instructor issues. Despite what seemed fairly regular use of this functionality, P4 confessed, "Canvas Analytics is not as useful. At least I haven't figured out a way to use them as…well as I should."

The Course Coordinator (P5) was the only participant from this academic unit who explicitly mentioned using **Canvas Quizzes**, providing "multiple choice types of questions" as a Formative Assessment tool to determine how students are grasping certain concepts.

All three Math participants described an approach to providing content and accepting student work that includes a combination of the **Canvas LMS** along with **Other Content and Submission Platforms.** Both P5 and P6 used products from the company Cengage that provide online content. These faculty members taught some of the same courses, and it seemed that P5, who has taught at the institution for several years, was responsible for establishing the use of Cengage, which was suggested or passed on to P6, who had been teaching at the institution for less than two years. In addition, P6 also used the platform Gradescope for creating and accepting homework assignments. According to this participant, Gradescope was a fairly new tool for which this higher education institution had only recently purchased licensing, and which this participant chose to pursue independently. Though using Gradescope ultimately proved beneficial, P6 described a difficult adoption process: "The learning curve for me last year really kind of kept me on the fence in terms of if I really saw it as something I could use and it was worth the time."

The Associate Chair also mentioned other platforms and tools used over the years, including the platform MathLab as well as "Clicker" technology for large lecture classes, which allows students to respond to questions using their smartphones. However, this participant mentioned cost and functionality issues that ultimately led to abandoning both of these tools.

Information Sciences

In the context of Information Sciences, I found examples of teaching across a range of modalities, and using both **Canvas Quizzes** and **Video** in different ways. While some participants mentioned using **Canvas Analytics**, they either found only limited utility or altogether questioned its reliability. Three of the participants taught the same course, and described some similar teaching practices, such as using **Other Submission and Content Platforms** including Jupyter Notebook to manage student programming work, and using a spreadsheet to maintain an additional Gradebook outside of the Canvas LMS. However, these participants seemed to have arrived at these practices more or less on their own rather than as a result of some coordinated approach to teaching the same course.

The three participants teaching the same Introductory Programming course (P8, P9, P10) all noted using **Canvas Quizzes**, though for different purposes. For example, P8 noted occasional use of Quizzes as a type of assignment in the course. P9 referenced "weekly quizzes" in what seemed like an approach to regular Formative Assessment, which will be explored further in the next section. In contrast, P10 explained, "I did use quizzes occasionally to take…opinion polls. But I feel like I never quite got it right in terms of…whether it's graded or not graded and how can I see the response? Like, I can't see the responses if it's not graded."

P7, P8 and P9 all described their use of **Canvas Learning Analytics**, characterizing various levels of utility. When examining grade distributions, P9 explained, "But that does help me. But not a huge amount…I mean, for me it's a nice dashboard, but [it] doesn't really tell me too much." P7, who teaches an asynchronous online course, provided the most detailed account, noting the types of data available and their utility, explaining, "So I have fooled around with…the sort of analytics…the [Canvas LMS] gives you…these funny relational statistics, right?...And, you know, I don't know quite what to make of those, honestly…And I don't know how the system is [making calculations]…Basically, I don't trust those numbers."

Both P8 and P9 briefly mentioned their use of **Video**, though for slightly different reasons. P8, who has taught an in-person version of the Introductory Programming course for multiple semesters, described how, "when you're in class and end up doing a lot of live coding, for example…so this semester I was trying to figure out what was the best set up so that I could record myself sort of on the screen." In contrast, P9 who was teaching a synchronous online version of the same course for the first time, explained how, "I record the lectures on Zoom and then we have office hours on Zoom." Neither participant went into detail about how exactly these video recordings are actually shared in their Canvas LMS course spaces, or their awareness of whether or not students use them and, if so, to what extent.

Both P8 and P9 also described their use of the **Submission Platform** Jupyter Notebook to facilitate student programming homework and projects. Again, having a few semesters worth of experience teaching the course, P8 described, "One common problem in all…introductory programing classes is that at the beginning of the semester you need the students to install" software, "and I realize that in the end it's been simpler for me to simply set up a Jupyter hub,…So that has eliminated that problem, but also has made it possible for us to use an auto-grader and to especially have control on the environment that students are using." Similarly, P9 mentioned some additional grading functionality built into this platform, "The assignments are all done in Jupyter Notebook, so they have to download a file or lately a zipped folder, go and do everything locally, and then load it back up. Yeah, so we have an auto-grader in the assignment with test cases, which are usually correct, but not always."

P10, who teaches an in-person version of the same Introductory Programming course, did not mention how or where students were completing their programming work. However, both P8 and P10 described grading practices that required maintaining an additional Gradebook outside of the **Canvas LMS**. P8 admitted to feeling "afraid of…messing up with the [Canvas LMS] Gradebook…[so] I have to keep everything in a spreadsheet and have [to] keep things in sync." Similarly, P10 described, "creating my own little system with grading and Google sheets that I know I can make it work. It might be easier to do it in [the Canvas LMS], but it might not at all."

Communication

Within the context of Communication, only the Co-Director of the GenEd program (P11), who had not recently taught, mentioned the use of **Canvas Learning Analytics**. Otherwise, both faculty members who were teaching the GenEd course (P12, P13) provided very similar descriptions regarding the design of the course, **Other Content Platforms** including e-textbook/resources they used, the use of **Canvas Quizzes**, and the use of **Video** in relation to student presentations. P14, who teaches other courses in the department, in both asynchronous online and hybrid modalities, provided details regarding how the use of tools like **Canvas Quizzes** and textbooks has evolved over time.

The Tenure Track Co-Director of the GenEd program (P11) spoke primarily about the reporting structure related to the Learning Outcomes Assessment which will be discussed in detail in the following section, as well as the way **Canvas Learning Analytics** have contributed to building the course shell that is shared with faculty. For example, P11 described the process of removing and then adding back a particular assignment. According to P11, being able to show the relationship between student engagement on one assignment with performance on another was essential: "Our instructors hated [a particular assignment], so we got rid of it. But then going in, we could get the learning analytics to show how much better students did on [the following assignment] and provide the rationale for why we needed to incorporate [the previous assignment] back in. And…the instructors are on board now. Students are on board now."

In terms of **Canvas Quizzes**, both P12 and P13 referenced the quizzes that feed into the GenEd Learning Outcomes report. P14, who teaches other courses in the Communication department, also mentioned having weekly quizzes in one course, used for Formative Assessment purposes. P14 described an evolving approach to quizzes to ensure their relevance to students: "They are untimed ten question quizzes…one of [my TAs] was creating the quizzes, and I found that she was doing them all…like definitions, and they weren't really…application. So, I kind of started to oversee that a little bit more."

These three Non-Tenure Track faculty members also described incorporating **Video** in different ways. Both P12 and P13 described the use of video in their GenEd courses. P12 mentioned, "I don't record every class session, but for the presentations we do use" the video platform Panopto, which is integrated into this institution's Canvas LMS. "So when I'm grading a presentation, you know, going back, looking at [the recordings] again while I'm doing the grade" (P12). P13 provided a similar description, discussing how video and audio capture works in the classroom, and how the recordings are then loaded into the **Canvas LMS** Panopto folder. P13 also mentioned providing students with other video content "that may not be in the textbook" and sharing it somehow through the Canvas LMS.

Both P12 and P13 referenced **Other Content Platform** including a textbook with a corresponding application used in the GenEd course. P13 clarified the limited content of this resource: "I wouldn't refer to that as integrated like some textbooks where it's…very…comprehensively integrated…This really isn't it. It's a PDF that they can read…[The] app that's available for the textbook is one where [students] can see videos that are embedded in the textbook. So…it's kind of multidimensional." P14 also mentioned using content from an online textbook in another course, but explained that it had eventually been removed since students were not meaningfully engaging with the content.

Business

In the context of Business, I found the unique perspective of instructional designers who were experts in the range of functionality that the **Canvas LMS** offers, and who had a desire to leverage available learning analytics to inform course design and assessment. These instructional designers described the importance of **Video** in the mostly online courses they support as well as the **Other Tools** and **Other Content and Submission Platforms** that faculty use but to which they do not usually have access.

Both Instructional Designers from Business (P15 and P16) can be considered Canvas ELMS experts, and both described their work designing course spaces for faculty members.

These participants primarily support online courses, with a significant dependence on recorded lecture and other **Video** and multimedia components:

> *We do use analytics in the sense of…video engagement…We will look at how students typically drop off after a couple of minutes. And so that influences how we encourage faculty to present information in various ways and limit their video production…A lot of what we look at in terms of insight is…how digital resources have been used and what we can take away from how much time a student has spent on a certain task or…feedback that they provide (P15).*

Both P15 and P16 also mentioned midterm and other student survey instruments, which I coded as **Other Tools**, which they have used to gain further insight from students. Moreover, P15 specifically mentioned how **Video** analytics, coupled with student feedback, informed how course materials are created and shared: "You know, engagement drops off, the longer the video goes. And you can generally see that when you look at video analytics, but getting some qualitative response about why…what other reasons there might be the students didn't fully engage the content I think is a really useful way to frame that data you're getting."

Finally, another issue that both participants addressed was the use of **Other Content and Submission Platforms.** P16 mentioned that for some courses, "there's a digital textbook and then there's… homework assignments that are" integrated into the Canvas LMS. Going a bit further, P15 described a general frustration with some of these materials, specifically mentioning those from the publisher Pearson, and Business instructional designers' lack of access to the materials and related analytics:

> *I…know…they [textbook publishers] create a lot of excellent content, which a lot of faculty really love. One of the issues, though, is…we [instructional designers]…don't have access to that. The faculty member assigns a book to their class. The faculty member has access to the dashboard, the students buy the book. But we [instructional designers] actually don't see any of that…It's actually an issue for us when we work with faculty…Okay, this stuff is going to be from the textbook and…I can't actually see what it is they're referring to (P15).*

Summary

As summarized in ***Table 4***, all participants mentioned some use of the **Canvas LMS**, from communicating with students, to storing and sharing content, to managing assignment submissions and grades. Beyond this general use of the Canvas LMS, I also identified those instructors who specifically mentioned using **Canvas Quizzes** for a range of purposes, including formative assessment and learning outcomes. Several participants mentioned their use of **Canvas Learning Analytics** dashboards currently available to instructors, but several participants mentioned that they did not fully understand them or did not find them very useful. With participants across academic units teaching in various modalities, I identified **Video** as a separate component, though only participants from Business mentioned accessing related analytics to inform design choices. Finally, many participants were using **Other Submission and Content Platforms**, with what seemed to be varying degrees of integration with the Canvas LMS.

Table 4. Learning Analytics Tools by Participant

Participant	Academic Unit	Canvas LMS-General	Canvas LMS-Quizzes	Canvas LMS-Learning Analytics	Video	Other Submission Platform	Other Content Platform	Other Tools
P4	Math	X		X		X	X	X
P5	Math	X	X				X	
P6	Math	X				X	X	
P7	Information Sciences	X		X				
P8	Information Sciences	X	X	X	X	X		X
P9	Information Sciences	X	X	X	X	X		X
P10	Information Sciences	X	X					X
P11	Communication	X		X				
P12	Communication	X	X		X		X	
P13	Communication	X	X		X		X	
P14	Communication	X	X		X		X	
P15	Business	X		X	X	X	X	X
P16	Business	X		X	X	X	X	X

Learning Analytics Purpose

Building on the previous section which focused on identifying learning analytics-related tools that these 13 academic unit participants mentioned using, the following section delves deeper into the purposes for which participants were using these tools. Among the variety of learning analytics purposes, Sergis & Sampson (2017) identify “analyzing learning and assessment activity types” and “capturing the flow of learning types”. Building on these somewhat broad categories, I used participant responses to arrive at six more specific learning and assessment activity types. I coded participant responses according to these six categories, which I define below:

- **Attendance/Participation:** This category relates to keeping track of student attendance, including when students sign into LMS or other online course space, and participating in class activities.

- **Engagement:** This category relates to determining what types of activities and materials students like the most and/or spend the most time on.

- **Formative Assessment:** This category relates to tracking student learning, usually through low(er) stakes activities including homework and quizzes.

- **Summative Assessment:** This category relates to tracking student learning on formal, major assignments including projects, presentation, and exams.

- **Learning Outcomes Assessment:** This category relates to determining student achievement based on predetermined learning outcomes.

- **Grades:** This category relates to managing individual student and overall grades across a course.

Math

In the context of Math, participants focused on activities related primarily to the areas of **Attendance/Participation**, **Formative Assessment**, **Summative Assessment**, and **Grades**. Among these categories, **Formative Assessment** and **Grades** seemed to be the most important, with all participants discussing relevant issues.

P4, as Associate Chair, taught small upper-level courses, while P5 and P6 taught large, 100+ student lecturer classes for lower-level, introductory Math courses including Pre-Calculus. Despite all participants speaking to the complexity of managing large numbers of students across the department, P4 was the only participant from Math to mention using Canvas LMS Analytics for purposes of monitoring **Attendance/Participation**. Using analytics for this purpose was largely related to P4's responsibilities responding to student complaints as well as considering student placement in particular Math courses, to determine if and when students were accessing materials and keeping up with Math courses as expected.

For all three participants (P4, P5, and P6), **Formative Assessment** throughout the semester was extremely important, in an effort to determine whether or not students are mastering certain concepts in order to move on to the next. For example, P5 mentioned that "our homework system [is] online so that also tells to me what problems [students had] more trouble with." Similarly, P6 described how certain tools "provide me kind of like really quick snapshots of…surface level statistics about how folks are doing in the course… informing…the next…day or two lesson to see if there's something I need to swing back to during teaching" and "give me at least some sense of how students are doing."

P4 and P5 only briefly discussed issues related to **Summative Assessment**, specifically midterms and final exams. P4 discussed issues related to weighting exams a certain percentage compared to homework assignments, as well as the practice of creating multiple versions of exams to limit the amount of potential cheating. P5, who mentioned that Math exams were still "pen and paper," described regular analytical practices such as "looking at the overall average, looking at the max" and even "looking at [male versus] female."

All three Math participants discussed managing **Grades** at length. P6 mentioned how the third-party submission platform Gradescope, as introduced in the previous section, was integrated with the Canvas LMS so that the Gradebook is automatically populated. P5 mentioned the usefulness of being able to review grades in the Canvas LMS, including averages on individual assignments as well as overall course grades, coupled with communication features in the Canvas LMS, making it possible to "send a message to anyone who's over a certain grade or under a certain grade."

Information Sciences

In the context of Information Sciences, I found evidence of participants teaching large (and very large) lecture courses, with a major concern of simply being able to keep track of **Attendance/Participation** and **Grades**, while also finding new and better ways of assessing student learning at scale. Participants referenced their attempts to assess students at different points along the learning process continuum, from **Engagement** with course materials to **Formative Assessment**.

The Tenure Track Co-Director (P7) regularly teaches an asynchronous online course with 150+ students. The Tenure Track (P8) and two Non-Tenure Track (P9, P10) faculty members all taught separate sections of the same Introductory Programming course, each with 50+ students. Accordingly, all four participants discussed some element of tracking student **Attendance/Participation**, with both P7 and P8 referencing the specific function of reporting enrollment to the University at the beginning of the semester based on whether or not students have signed into the Canvas LMS course space.

The two Tenure Track participants discussed issues related to **Engagement**, and the relationship between engagement with course materials and student achievement. For example, P7 mentioned using “both quantitative and qualitative [data] collected about students in order to try to assess…their engagement…If there are students who haven't turned in assignments that I also will look to be like, you know, have they been looking at all at the assignments? Basically, are they even engaged in the class and they're just behind or do they not appear to be in the class, particularly at all?” More specifically, P8 described the utility of Canvas learning analytics that provide page access data: “when the student has access to the course page on how much time they spent on it, you can go down to the individual elements of the student to access the page of a particular assignment and so on and so forth."

P9 was the only participant from Information Sciences to mention **Learning Outcomes,** though it was discussed in terms of a desire rather than something this participant was currently doing: "I don't know who's learning what and to what extent. And so it would be ideal if there was some sort of analytical component which said, okay, like this is a way of measuring quantitatively what's been achieved as far as outcomes…are these students learning things that actually meet the objectives and goals of the class?"

All four participants mentioned the essential task of tracking student **Grades**. While not using the term **Learning Outcomes** explicitly, P10 described an alternative approach to grading that this participant was piloting: "So I tried to really push back…against a point system for grading. And I tried to come up with more of a sort of criterion based" approach that considers whether or not students are able to accomplish certain programming tasks." I included P10's response in the **Formative Learning** category, but clearly both P9 and P10, both in their first semester of teaching the same course, possessed a similar desire to craft an alternative, or complementary, approach to assessing student learning beyond a purely grade-based system. While all participants described managing homework and other activities both in and out of the Canvas LMS, only P9 mentioned a final project which I coded under **Summative Assessment**.

Communication

In the context of Communication, I found extensive use of the **Canvas LMS** for managing the entire learning process, leading up to and including **Learning Outcomes**

Assessment in the GenEd course. I also found evidence of a reporting channel between the College and the Co-Director of the GenEd program that provided aggregate student and instructor data, though the instructors actually teaching these courses did not mention any awareness of this reporting or any impact on their teaching.

In terms of tracking **Attendance/Participation**, three Communication participants (P11, P12, P14) described the practice of tracking student login and activity in the Canvas LMS. In particular, P14 described how "I can see…when the last time [students] logged in, how many hours they spend on [Canvas LMS] page…The only time I ever check is if there is like a student who claims to have some type of issue or for roster verification." P12 described how keeping track of participation on activities has taken the place of attendance tracking, while also allowing students who are unable to attend an in-person class to receive credit and participate in the learning process: "We're shying away from taking attendance at all…you're in class and you do the activity. Okay, well, unless you go on [to the course Canvas LMS site] and do it, you can't get the points. But, also, maybe you're not in class. Well, you can…still do the activity."

In terms of **Engagement**, P13 provided a general definition of learning analytics that included "being able to track student engagement, student behavior to determine how students are learning and if students are learning." Providing more detail about tracking Engagement, P14 described the process of using an online textbook that instructors eventually determined was not useful: "We have since phased [the textbook] out this semester because we found that…students basically get 100 just for doing it. So students were just like kind of clicking through it really quickly and not actually engaging with the material."

As mentioned, the GenEd program that P11 manages, and where both P12 and P13 teach, provides what participants described as a fully developed course shell for instructors, with all assignments and materials, including **Learning Outcomes Assessment** components. Sections of this GenEd course are capped at 19 students, and these three participants all described similar elements of teaching the course in terms of **Formative** and **Summative Assessment** and of tracking student **Grades** in the Canvas LMS.

The Co-Director described the GenEd program's **Learning Outcomes Assessment** practice, which depends on coordination with the College of Arts & Humanities Office of Undergraduate Studies:

> *We rely on the report that the Office of Undergraduate Studies gives us. Now the learning outcomes assessment is facilitated through [the Canvas LMS]. We have it built into [the Canvas LMS], but then it pushes out to the Office of Undergraduate Studies and they collect all the data and then give it back to us…the process has been in place for years and years and years …we're…able to reflect on maybe what happened or what the trends are or how we're going to address any problems (P11).*

Again, the other participants teaching sections of this course mentioned these Learning Outcomes components within the course shell, with P13 mentioning, "I don't know how great that is because it's an open note quiz to begin with."

The Non-Tenure Track Communication participant not teaching in the GenEd program (P14) was instead teaching both a fully online course with 50+ students and co-teaching a hybrid course with 100+ students. Similar to responses from Math and Information Sciences participants teaching large lecture courses, P14 characterized significant **Formative** and **Summative Assessment** and overall **Grading** practices, including, "I use [the Canvas LMS] SpeedGrader…and I look at the averages for each assignment you know at the top like it'll tell you the average percentage…So I do like look at that and kind of take that into account like if an assignment I think maybe was too rigorous or too easy or something." This participant also mentioned a concern for **Learning Outcomes**, "When I think about them in terms of…the classes…that I teach is…the learning outcomes…[are]…what we want students to have attained and be able to apply from what they have acquired in our class that semester." Other than this general concern for learning outcomes, this participant did not mention any sort of formal mechanism for accomplishing this sort of measurement, such as the tools used in the GenEd course.

Business

As instructional designers, the two participants from Business (P15, P16) were Canvas LMS experts responsible for building and updating course spaces for faculty members across a range of mostly online undergraduate, graduate, and professional courses and programs. But these two participants were not actually teaching courses, and, therefore, did not have access to, and did not speculate about, **Attendance/Participation** or **Grading** practices.

Instead, both participants focused on their efforts to track **Engagement** and **Formative Learning**. For example, P15 mentioned the relationship between student engagement with course materials and course assignments, "We try to look at…when and how do students actually interact with the course content [in the Canvas LMS], because that's at least a kind of…neutral arbiter…What are they actually doing?...Did they actually even look at this page? [Did] they look at this content to download it? Did they watch a lecture video?...How much of the video did they watch?...And then oftentimes try to connect that to assignments."

Similarly, P16 described the practice of tracking "engagement with…the material, how much students are turning in and…how much of it is on time." However, P16 went on to discuss some of the internal discussions the instructional design team has had about learning analytics might be problematic, in particular, "the potential for…a punitive approach." This participant described a hypothetical instructor: "If you see certain students that are lagging behind what influence that could have over how they're viewed in the course…being able to see exactly how much time someone spent on a certain thing or in the quizzes." P16 worried that in some circumstances, instructors or administrator use of such metrics could have negative implications for students.

Again, while both participants shared a similar concern for being able to track and enhance both **Engagement** and **Formative Assessment**, only P15 explicitly described what role **Learning Outcomes** might play:

> *In an ideal world…the structure for any…course development, whether it's a new course or it's revising an existing course, would be some form of…model where you…analyze…who are the learners in advance. And then you think about…what learning outcomes [are] we [trying] to target for this program,…then build the course. And then, at the end of the course, evaluate,…how [do] the learners actually engage with that content (P15).*

P15's description pointed to a desire to incorporate more evidence-based, learning analytics-enhanced approaches to course and program design that, according to this participant, currently are not happening.

Summary

As found in ***Table 5*** below, all but the Business participants in some way discussed their practices related to keeping track of student **Grades** both in and out of the Canvas LMS.

Participants from Communication were most likely to discuss **Summative Assessment**, as it related to major projects, while only one participant from Information Sciences (P9) mentioned a final project, and two participants from Math (P4, P5) mentioned tests or final exams.

The **Attendance/Participation**, **Engagement**, and **Formative Assessment** categories might be understood as existing on the same continuum leading to **Learning Outcomes Assessment**, and, at times, seemed to overlap with each other. Therefore, I only coded when participants explicitly referenced the term Learning Outcomes, and used the other categories as a means of recognizing the range of activity that participants believed learning analytics did or might capture, from tracking student LMS login, to time and effort spent on specific materials, to periodic assessment practices throughout the course.

Table 5. Learning Analytics Purpose by Participant

Participant	Academic Unit	Attendance/ Participation	Engagement	Formative Assessment	Summative Assessment	Learning Outcomes Assessment	Grades
P4	Math	X		X	X		X
P5	Math			X	X		X
P6	Math			X			X
P7	Information Sciences	X	X	X			X
P8	Information Sciences	X	X	X			X
P9	Information Sciences	X	X	X	X		X
P10	Information Sciences	X		X			X
P11	Communication	X		X	X	X	X
P12	Communication	X		X	X	X	X
P13	Communication		X	X	X	X	X
P14	Communication	X	X	X	X	X	X
P15	Business		X	X		X	
P16	Business		X	X			

Synthesis of Research Question 1 Findings

Tools	Purpose
Canvas LMS used across units and courses. • GenEd Communication provides course shell for uniformity. • Information Sciences teaching same course but designing on their own.	**Attendance/Participation** tracking important Canvas LMS function. Business only unit accessing video analytics for **Engagement.**
Video, Quizzes, Analytics used in different ways across units.	**Formative Assessment** most important for Math and Information Sciences.
Variety of **Content and Submission Platforms** used across units.	Communication only unit with formal **Learning Outcomes Assessment** mechanism.

As presented, I identified some notable differences between these academic units. With the Communication GenEd course, I found the context of a single, highly standardized course that most or all undergraduate students at this higher education institution must take and which every instructor must teach more or less the same, a context which has lent itself to a seemingly highly developed monitoring and evaluation structure. In somewhat stark contrast was Information Sciences, where I found no evidence of this sort of activity, and Math, for which there were numerous courses that students might take according to their current proficiency level, and for which it seemed a single Administrator was responsible for sifting through a range of data sources to address instructor-student situations when they arise and make placement decisions when necessary.

The highly standardized GenEd course, and the number of online courses across academic units, might partly explain what appears to be a high Canvas LMS adoption rate among these participants. Though, as described, participants have varying comfort levels with and experience using the Canvas LMS, with participants noting the additional complexity of managing large classes while attempting to integrate other content and submission platforms into their teaching practices.

In the previous sections my goal was to identify what learning analytics-related tools these academic unit instructors were using and for what purposes, focusing primarily on responses across academic units. To consider related issues across stakeholders and academic units, I identified three separate topics for which there appeared to be broad learning analytics-related implications. These topics included Course Modality, Aggregate Data, and Learning Outcomes Assessment.

Course Modality

Course modality, in particular the shift towards online versions of courses, was a significant issue for Business, Information Sciences and Communication. The instructional designers from Business almost exclusively provided support to online courses and programs which included classes going towards a fully online undergraduate minor. The Co-Director of Information Sciences had taught a large online course for multiple semesters, and the three other Information Sciences participants taught sections of the same course but in different modalities, some online, some in person. From Communication, P14 teaches both an online course and co-teaches a hybrid course.

This high number of online courses contributed to what seemed to be a high adoption rate of the Canvas LMS overall, as well as significant use of Zoom, Panopto and other video capturing and hosting platforms across academic units, though only participants from Business mentioned using video analytics to influence design and track engagement. While all the GenEd Communication courses were offered in person, the Co-Director hinted at a desire for creating more online sections, but claimed “my department does not believe in offering online classes during the semester.”

Considering the growth of online learning at this institution, and the wide range of tools and platforms that participants were using, there seem to be significant opportunities to provide more and better ways of capturing student engagement with materials with an overall goal of assessing student experience and performance across modalities.

Aggregate Data

While participants were accessing learning analytics-related data for a range of purposes related to managing the learning process across a variety of courses, there was significant inconsistency in how administrators and other participants were able to access aggregate data.

Among the Administrators, including the Associate Chair from Math (P4), the Co-Director from Information Sciences (P7), and the Co-Director from Communication (P11), I identified some significant differences in how they are accessing and using data for their leadership roles. The Information Sciences Co-Director did not mention any activities related to tracking individual instructor or aggregate data. The Math Associate Chair described what seemed to be the fairly regular task of going into instructor Canvas LMS spaces to account for both individual student and instructor activity, and also mentioned accessing a range of other student data to make assessments related to course placement. In contrast, the Communication Co-Director mentioned using a separate dashboard in the Canvas LMS to review instructor grade distribution across assignments, which helped to facilitate grade norming activities.

The Tenure Track participant from Information Sciences (P8), who had taught the same Introductory Programming course for multiple semesters, described an interest in aggregate data but had not done so and was unclear about whether or not others in the department were collecting and analyzing this sort of information:

> *I thought about comparing the…performance across different sections…We've been teaching [the Introductory Programming course] for a long time…And I think they do monitor it a little bit. And I believe that also…coordinators to do that, too. But [I] haven't really addressed [it] myself at this point. I haven't really looked at trying to compare, you know, the DFW rates across sections of things like that (P8).*

One of the Non-Tenure Track participants from Information Sciences (P9), also teaching the same Introductory Programming course but for the first time, put it more bluntly, "I actually don't have much sense of what the history of the classes or historical outcomes are."

Speaking from an Administrator perspective, and specifically about the reporting provided from the College of Arts & Humanities, the GenEd Communication Co-Director (P11) discussed the issue of instructor privacy and how data might be used:

> *I think sometimes ther''s this assumption that people's courses are their own because they're the instructor [of] record. But…mining the data and having this aggregate data isn't for us [as Administrators] to…target any specific instructor…And I think that's probably why…there hasn't been some questions raised about privacy of their own individual sections, because…the way that we use the information is one aggregated but two…it doesn't impact them (P11).*

The Program Manager from Business (P15) mentioned the usefulness of looking at courses that have run multiple years: "If you have a course that is running over and over again, it'd be great to be able to…[conduct a] meta-analysis" to determine how, for example, a certain “assignment routinely is one of the most challenging assignments and has…the highest level of failure or anything like [that].”

One of the instructional designers from Business, P15, mentioned the difficulty of trying to access some aggregate data: “most analytics [are] separated by course, right? So, it’s hard to see how our freshmen this year are doing compared to freshmen last year…And it’s not to say that that couldn’t be done, but it would require someone with a lot of time…to collect all of that and do that.”

From Math, both the Associate Chair (P4) and the Non-Tenure Track instructor working on Bridge programs (P6) discussed data collection processes over the last year, with both describing that more work needed to be done. In particular, P6 described the importance of “reflecting…on student performance and the data that’s…available to us as a department and trying to use that to…create a story so that we can, for instance…with the Bridge programs,…it gives us a place to say…, here's what's going on…semester-to-semester,…giving a rationale…[and] using that data to argue for the need to improve instruction and specific courses.”

These academic unit participants were accessing and making decisions based on a wide range of data derived from the various tools they were using to manage their courses. Yet, there seemed to be few options for considering courses over multiple semesters, or multiple years. These limited options seemed to be the result of both technical limitations of accessing these data, as well as a hesitant, if not skeptical, campus culture surrounding the use of these data.

Learning Outcomes Assessment

As the Co-Director of the General Education Communication Program (P11) explained, nearly ten years ago the program worked with a previous team from the Teaching and Learning Center to develop a Learning Outcomes Assessment dashboard within Canvas. This dashboard remained essential to the assessment and faculty management practices of the leadership team of this program. However, one of the Non-Tenure Track faculty members teaching the course for the first time (P13), mentioned, “I don’t know how great [the Learning Outcome Assessment] is because it’s an open note quiz to begin with.”

P14, the Non-Tenure Track faculty member teaching Communication courses outside of the GenEd program, provided further insight into the University’s commitment to learning outcomes, noting a potential disconnect between what leaders might say and what is actually happening:

> *Honestly, like this is maybe going to sound bad for the University, but I feel like we do a lot of, like, “Let's pay attention to these [learning outcomes] and they are really important,” but I don't know how much we actually measure them. I feel like…we may do…some surveys and stuff here or there, and…classes are supposed to build on each other, but I think most of the time we’re just kind of keeping it at the forefront and hoping for the best (P14).*

No one from Math mentioned Learning Outcomes explicitly, though the Non-tenure Track faculty member working on developing Bridge programs (P6) did seem to have similar concerns in mind, as presented in the previous section on Aggregate data. Only one participant from Information Sciences (P9) mentioned Learning Outcomes: “I don't know who’s learning what and to what extent. And, so, it would be ideal if there was some sort of analytical component which said, okay, like this is a way of measuring quantitatively what's been achieved as far as outcomes…are these students learning things that actually meet the objectives and goals of the class?"

This desire was similar to the Business Program Manager's (P15) discussion of an "ideal" design process, which would include determining "what learning outcomes [are] we [trying] to target for this program,…then build the course. And then, at the end of the course, evaluate,…how [do] the learners actually engage with that content." According to this participant, this sort of design process, including a concern for learning outcomes, is not currently happening, at least not very frequently.

Like the issue of aggregate data, learning outcomes assessment seemed to be an important area with differing opinions and approaches across these academic unit participants. While there appeared to be at least some level of recognition of the importance that learning outcomes assessment might play across all academic units, only the GenEd Communication program had a system in place that leveraged Canvas LMS dashboard and reporting functionality.

Chapter 5: *Research Question 2* Findings

What are stakeholders' teaching and learning backgrounds and experiences, and to what teaching and learning related resources do they have access?

I derive my findings in this chapter from responses from the 13 academic unit participants. As described in ***Chapter 3***, these 13 participants provide the foundation for the descriptive elements of this embedded case study.

My findings for my first research question established that within this higher education institution, teaching – and, specifically, teaching with learning analytics– is happening in a range of ways, with differences not only among disciplines and academic units, but also among faculty teaching in the same academic unit, even faculty teaching the same course. This finding was my first step towards situating learning analytics-related practices within this higher education institution as representative of a complex adaptive system (CAS), which, according to Ueland, et al. (2021), demands unique approaches to managing and affecting change.

My goal with my second research question was to capture how these participants arrived at their current teaching practices, including their use of learning analytics-related tools and approaches. I accomplished this by considering participants' teaching and other backgrounds and experiences, as well as their discussion of various resources to which they have access at this institution and beyond. Accordingly, my findings in this chapter are intended as a response to Dawson, et. al (2018), who recognize that the "organizational level of analytics adoption is not so well understood. One approach to better understand this space is to draw on analyses of social capital and organizational network structures" (p. 243).

First, I summarize participant responses related to their personal backgrounds and experiences, organizing responses by academic unit. Next, I consider the range of academic unit, University, and other resources that participants mentioned having used, again, organizing responses by academic unit. I end the chapter with a synthesis of responses across participants according to two main areas: Collaboration and Canvas LMS and other Tools Training.

Backgrounds and Experiences

In this section, I use Fives & Buehl (2008) Teacher's Knowledge Framework, defined below, to consider my participants' backgrounds and experiences as they presented them:

- **Pedagogical Knowledge:** This type includes general knowledge of teaching methods, practices, and assessment.
- **Knowledge of Students:** This type includes general knowledge of how students learn.
- **Content Knowledge:** This type includes knowledge of a particular content area, including pedagogical and curriculum concerns specific to that content area.
- **Management and Organizational Knowledge:** This type includes knowledge about managing a classroom and organizing tasks.
- **Self/Other Knowledge:** This type includes knowledge of one's own strengths and weaknesses.

Math

All Math participants had relevant graduate education, providing significant **Content Knowledge**, as well as significant previous teaching experience, both at this institution and other previous higher education institutions. As expected, this previous teaching experience appeared to contribute to an awareness of and concern for a range of teaching issues, including an awareness of the types of students in their courses, how the learning process works, and how to manage and organize their courses.

While P6 was relatively new to this higher education institution, this participant arrived with both previous teaching experience and graduate education focused specifically on Math Education. P6 also described an initiative focused on improving the undergraduate Math program that included “setting up some what we call like Bridge Programs which are like more or less like sort of math bootcamps to help students who are struggling in their courses…it’s kind of a new thing within the Math department and…gives some like educational perspective about the undergraduate courses.” P4 and P5 both had decades of teaching experience between them, undoubtedly contributing to their positions of Associate Chair and Course Coordinator. Overall, these three participants possessed deep **Pedagogical Knowledge** and **Knowledge of Students**, specifically in the context of Math classrooms.

While the Associate Chair (P4) had recently only taught smaller, upper-level courses, all three participants focused much of their discussion on the many issues related to teaching “large lecture” courses, with hundreds of students, spread across multiple sections, meeting multiple times a week. As the Course Coordinator (P5) explained in terms of the Pre-Calculus course, the number and types of sections change from semester to semester, with approximately “ten sections in fall, and the 6 to 8 section this spring. [In the fall] I’m…doing…the main version of the course, but then in spring” there are special sections for first-year students who are entering the institution through a special admissions process.

Therefore, in terms of their current teaching responsibilities, much of these three Math participants' discussions related to the **Management and Organizational Knowledge** type.

In Chapter 4, I identified that only the Associate Chair used Canvas Analytics Dashboards, and was the only Math participant to track attendance and participation. Yet, both P5 and P6, who oversee multiple sections of large lecture courses, seemed most in need of ways of tracking and accounting for student activity in their courses. These participants seemed to possess deep insight across all Knowledge types; however, while using a range of tools and data to inform their course design and course management practices, these participants seemed dependent on their past experience and personal intuition rather than on representative data beyond student grades.

Information Sciences

Similar to Math, Information Sciences participants focused much of their discussion on the difficulty of supporting large lecture courses, with multiple teaching assistants across different course modalities, requiring a great deal of both in-person and virtual course **Management and Organizational Knowledge**.

Information Sciences participants had previous work experience in industries that were relevant to the Introductory Programming courses that P8, P9 and P10 were teaching and the majors of students taking their courses. I situated these other experiences into the **Self/Other Knowledge** category, as they clearly related to how these participants were teaching their courses and how their courses potentially related to their students' potential academic and career paths.

Both P9 and P10 were Non-Tenure Track faculty members in their first semester teaching in Information Sciences at this institution, and both learned of their teaching assignments less than two weeks before the semester started. Both were given a sample syllabus, but both said they did not use it, at least not entirely, and, based on their descriptions of their teaching, have gone in somewhat different directions. This situation presented a significant learning curve for both of these participants, making them both acutely aware of some of the course design issues they still need to address in order to meet the needs of their students. Despite having previous teaching experience, P9 and P10 seemed overwhelmed by the work their courses presented. P8, who is Tenure Track, also teaches this course but had two previous semesters experience and, accordingly, seemed more knowledgeable of the course and had established teaching practices.

Compared to Math, Information Sciences participants teaching the same course seemed ill-equipped to teach their courses. While they possessed previous teaching experience, which provided some general **Pedagogical Knowledge** and **Knowledge of Students**, this previous experience did not seem to translate to their current teaching responsibilities. As presented in the previous chapter, these participants also had very inconsistent course design practices, including their use of the Canvas LMS, especially as it related to grading.

Communication

In the context of Communication, the two participants teaching the GenEd course, along with the Co-Director of the GenEd program, focused much of their discussion on the course shell and pre-determined structure of the GenEd course, with little mention of issues related to **Pedagogical Knowledge** or **Knowledge of Students**. This finding contrasted with the experience of P14, who spoke at length about issues related to managing larger courses, determining effective course materials, and interacting with a co-teacher, teaching assistants, and students across courses.

Participants from Communication seemed to have less relevant teaching and other experience that related to their current teaching and other responsibilities. For example, while all participants from Communication had relevant **Content Knowledge** as a result of their graduate education, P12 and P13 were teaching the GenEd course for the first time and shared little detail relating to their awareness of their students or relevant pedagogical approaches. Sections of the GenEd course are relatively small, capped at 19 students. This small class size might explain why these participants had little to discuss in terms of course **Management and Organization** issues in the same way Math and Information Sciences participants discussed their large lecture courses. Also, this lack of discussion regarding course management and organization might relate to the structure of the GenEd course, since instructors are provided with a course shell with virtually all course materials, activities, and assignments. While participants mentioned some options for personalizing their courses, in general P12 and P13 seemed to have much less control over, or engagement with, the structure and functioning of their GenEd course as compared to P11, who was teaching other, larger Communication courses with which this participant was very involved in course design and management.

The Co-Director of the GenEd program (P11) was not currently teaching, and, therefore, focused more on issues related to the content of the course and monitoring learning outcomes, with less discussion about the experience of actually teaching the course. Nevertheless, P11 provided the following insight regarding the structure of the GenEd program and its impact on students: “I do think that having that consistency in place in like these large multi-section courses only benefits undergraduate students because then you're not having these completely disparate learning experiences and a GenEd course that should be fairly similar."

P12, who teaches a section of the GenEd course and also serves as an Assistant to the Chair, described the department's "self-study" that was underway. According to P12, these self-studies are completed only once or twice every decade, meaning a Chair will likely only ever do it once: "We've really had to figure out, okay, what is it that we're analyzing? What are the analytics that we're looking at?…How are we going to collect the data? What are we going to analyze? And there's just a lot of components of it, like, people and each kind of constituent [to] consider…staff, professional track, tenure track, graduate students, and undergraduate students."

Recognizing this range of perspectives to consider, P12 considered, "it's interesting to see…what the undergraduate students have to say about the curriculum and what they're learning versus what the tenure track [faculty have] to say." I did not explicitly ask any of the other participants about this self-study, and none of the other participants mentioned having contributed to it in any way. Nevertheless, being involved in the data collection process of this self-study seemed to provide P12 with greater insight into general **Pedagogical** issues facing the department, despite limited direct student engagement or classroom experience.

Like the Information Sciences participants teaching the programming course for the first time, the GenEd Communication participants who were newer to the University were learning their courses as they were teaching them. While the Information Sciences participants seemed to lack confidence about their courses, they were very aware of the issues facing their students and the need to somehow improve the design of their courses.

Armed with a course shell providing more or less all aspects of the GenEd course, the Communication participants seemed somewhat more confident, but less aware of, or concerned with, issues their students might be facing or anything related to course management and organization.

Business

While both Business participants arrived at their current roles with previous teaching experience, providing them with **Pedagogical** and **Student Knowledge**, neither was currently teaching in the classroom. Neither Business participant mentioned previous Business or related degrees that would contribute to relevant **Content Knowledge** for the courses or programs they support. Since they are not involved with teaching or otherwise supporting the courses and programs they help to design, neither participant discussed issues related to course **Management and Organization**. The Program Manager (P15) in particular recognized the limitations to the support Instructional Designers are able to provide since they rarely, if ever, have the opportunity to see how faculty and students are actually using the materials they provide.

Perhaps most telling was P16's discussion of an "ideal" design process:

> *In a perfect world, after every course…I would meet with the faculty member. We would look at surveys, we'd look at the analytics and we'd say, okay…what can we learn from this and what iterations should we make for next time? The reality of…the timetables and how busy everyone is, that process generally doesn't happen unless there's a problem. And oftentimes that problem is at a higher level. Right. Like some students have complained not to the faculty, but [to]…program directors, and the program directors are…coming back to us and say, "Hey, students are complaining about this…can you look into it?" and then that kind of happens (P16).*

This description represents a deep understanding and commitment to iterative, evidence-based course design, but a certain frustration with being unable to regularly engage in this sort of reflective practice. In contrast to this usual approach to supporting courses, P16 did describe one instance of a new initiative related to a graduate program:

> *You know, actually in a kind of a rare moment where we recently launched a new online master's program. And we are actually for the first time, I think, in many years, [will sit] down with all the faculty…next month and try to get some feedback and…look ahead because it's a really new program and they're…aware that they're trying something new and they want to be responsive. But, generally, that really only happens when there's a problem (P16).*

As ever, a major limitation in my consideration of the case of Business is a lack of insight from faculty members and administrators from this academic unit. Nevertheless, from the perspective of these instructional designers possessing significant learning analytics-informed **Pedagogical Knowledge**, in the context of Business these resources do not seem to be leveraged in a proactive, strategic way except in rare instances.

Summary

In terms of the Knowledge Types summarized in ***Table 6***, perhaps the most significant difference is between the Math and Information Sciences participants on one side, and Communication and Business participants on the other. In Math and Information Sciences, large lecture courses, coupled with a lack of consistency in teaching approaches across participants, resulted in long discussions about understanding student experience, designing and assessing the learning process, and, more generally, managing such large student populations. In contrast, the Communication participants teaching relatively small

GenEd courses for which they were provided virtually all materials in the form of a course shell seemed to translate into few, if any, concerns about many of these issues.

All participants, including the Instructional Designers from Business, arrived at their current positions with previous teaching experience, which clearly gave everyone at least general **Pedagogical Knowledge** and **Knowledge of Students**. However, in many cases, this previous experience did not seem sufficient for these participants' understanding of the students and courses they were currently teaching, representing their interest in data and other resources related to their current course design, management and assessment practices.

Table 6. Knowledge Types by Participant

Participant	Academic Unit	Pedagogical Knowledge	Knowledge of Students	Content Knowledge	Management and Organizational Knowledge	Self/Other Knowledge
P4	Math	X	X	X	X	X
P5	Math	X	X	X	X	X
P6	Math	X	X	X	X	X
P7	Information Sciences	X	X	X	X	X
P8	Information Sciences	X	X	X	X	X
P9	Information Sciences	X	X	X	X	X
P10	Information Sciences	X	X	X	X	X
P11	Communication	X	X	X		X
P12	Communication			X		X
P13	Communication	X		X		X
P14	Communication	X	X	X	X	X
P15	Business	X	X			X
P16	Business	X	X			

Academic Unit, University and Other Resources

Building on my consideration of participant backgrounds and general teaching practices, in this section I consider the specific resources that participants mentioned using, or having access to, in support of their current teaching and other roles, especially as they related to learning analytics-related teaching and course management practices. I identified the following six types of resources:

- **Leadership/Support:** This category includes academic unit, departmental or any other roles including department chairs, course coordinators, assistants or other staff whom participants access for support in their teaching practices and other responsibilities.

- **Colleagues:** This category includes other faculty or staff with similar rank, often teaching the same or similar courses.

- **Teaching Assistants:** This category includes graduate assistants, undergraduate teaching assistants, and graders, who have a variety of access to and responsibilities related to tracking student participation and learning in courses.

- **Orientation/Training:** This category includes specific orientation and training series provided by the academic unit.

- **Teaching and Learning Center:** This category includes accessing resources from the Teaching and Learning Center website, attending Teaching and Learning Center trainings and functions, and consulting with Teaching and Learning Center staff.

- **Internet/External:** This category includes finding relevant resources online as well as training/knowledge gained elsewhere that directly contributes to participant teaching practices and/or learning analytics usage.

Math

In the context of Math, P6, though a recent hire, seemed to provide a unique perspective in terms of being aware of and accessing a range of resources related to this participant's current teaching as well as other initiatives. As described, both the Associate Chair (P4) and Course Coordinator (P5) from Math have many years of experience at this institution, and, accordingly, a deep understanding of the courses they teach, for which they have assembled relevant teaching materials and implemented teaching practices over the years. Given this experience and the roles they play, neither of these participants mentioned using any resources within the Math Department, elsewhere at the institution, or anywhere else. Only P5 mentioned having a number of **Teaching Assistants** that this participant referred to as being part of the "team" that supports the Pre-Calculus courses.

Therefore, as a relatively new faculty member, P6 stands out as the one participant from Math most involved in connecting with resources related to teaching. In terms of accessing **Leadership/Support** personnel, P6 mentioned that, "the course coordinator…sent out sort of an email blast to everybody teaching the course with…some screenshots and instructions about…how to integrate these things like [the Canvas LMS] and [a related] website, for instance…So that was really helpful." In terms of **Colleagues**, P6 did not mention seeking out guidance from peers but instead mentioned being "asked by the department to join…[a] committee of people who help decide…what math courses in the State count towards…high school credit for students." This committee seems to serve as a significant opportunity for this participant to engage with others in the department.

Finally, in terms of **External** support, P6 also mentioned, "We actually have…a dedicated representative from [the content platform] Cengage…that we can reach out to if we need help," but it did not seem like this participant had actually used that resource. Instead, in relation to the Pre-Calculus course specifically, P6 mentioned collaboration with faculty members at other institutions: "So we're part of a network of several universities that are also doing the same thing of…redesigning some…math courses. And…we've shared and collaborated on…different analytics."

Information Sciences

Overall, information sharing seemed limited in the context of Information Sciences, with little, if any, interaction among colleagues teaching the same course, representing a significant disconnect between how the Tenure Track Co-Director believed the course was being managed when compared to the perspectives of the faculty members actually teaching the course.

According to the Co-Director from Information Sciences (P7), learning analytics was not discussed among **Colleagues**: “Yeah, shockingly, I would say we don’t talk about it…We don't talk about learning analytics in our own teaching a ton colleague-to-colleague…You know, we’ll talk about other sort of facets of teaching, but analytics hasn’t come up in a huge way in our sort of conversations…, which is interesting. It comes up as a research topic.”

Further discussing information sharing and collaboration in the department, P7 described the process of designing and managing a large asynchronous online course which the participant seemed to have originally conceived of and developed all alone: “It’s just my baby, right? Like, I made it up…and then I teach it. And… now we have a Ph.D. student who I mentor who’s also teaching in person…in some ways I've been…too in charge of this class, like, I need to sort of get some more people involved.”

In contrast, P7 described the Introductory Programming course that the other participants taught as a “truly collaborative effort.” Yet, according to P8, P9 and P10, who were teaching sections of this course, each described receiving an email with some materials at some point but otherwise have gone about developing their courses on their own. In short, teaching different sections of this course had not been a collaborative effort. Indeed, P8, the

Tenure Track participant also teaching the Introductory Programming course, mentioned, “I reached out to a couple of colleagues who were kind enough to share their own material.” That is, materials were not shared automatically but the participant had to seek them out. P8 was also the only Information Sciences participant who mentioned accessing resources from the **Teaching and Learning Center**, again, on this participant’s own initiative, when first hired by the institution.

Otherwise, these participants mentioned that the most significant interaction among colleagues related to a separate research initiative with external funding and involvement from others beyond the department, but this initiative was only at the discussion stage at the time of our interviews. Participants did not describe any interaction with **Leadership/Support**, other **Colleagues,** or **External** support.

Both P9 and P10 mentioned working with **Teaching Assistants** to support their courses, though P10 described the situation as more of a burden than a resource: “Like that's been one of the more overwhelming things for me…like, I don’t even know how to give all you people stuff to do…I think in total I’ve got something like 13 TAs…I don’t have time to run a course and be a supervisor to all of you people.” In this case, teaching assistants were assigned to the course without input from or guidance to the faculty member teaching the course.

Communication

In the context of Communication, both within and beyond the GenEd program, there seemed to be a significant culture of information sharing overall, including interaction among **Colleagues** and access to **Leadership**.

The two instructors teaching the same GenEd course (P12, P13) spoke in similar terms regarding the internal support of the program, including the **Orientation/Training** they received before the semester started, the course shell that was provided as a part of the training, their access to course mentors and other programmatic **Leadership**, and the ease and frequency of engaging with their **Colleagues**. P13 described, "I've been able to ask questions of my colleagues and get, you know, people who…have been teaching this course or teaching using [the Canvas LMS] for longer…[and they] have been very helpful."

P14, who was co-teaching a hybrid course with another faculty member, described similar levels of support: "As faculty…we have course supervisors, we also have peer mentors in the department. I don't really take advantage of that, but we do have like peer mentors who can help you with assignments and things. But I do work…closely with the course supervisor…So like every summer before the next year, we'll meet and…go over the syllabus and see if there's any issues that were happening."

Business

Both participants from Business acknowledged that having some understanding of, and recognizing the importance of, learning analytics was more or less synonymous with their positions as Instructional Designers. Compared to the other participants in leadership and teaching roles in other academic units, P15 and P16 were examples of human resources that others might reach out to, if such resources actually existed in other academic units.

While P15 mentioned interaction with program directors and other leadership, it was in the context of being given a directive to work on a certain project – usually to solve a problem – as previously discussed. Thus, neither of these participants mentioned looking to **Leadership** or others for support. In general, these participants focused on working independently with some discussion among their team of **Colleagues** that consists of several other instructional designers. Even though P15 is a Program Manager, to whom P16 reported, neither participant discussed their work in any sort of hierarchy, again, focusing primarily on the individual support they provided to different faculty members or program directors. Only P15 mentioned going to the **Internet** to look up resources, adding, "I feel maybe arrogantly confident…I know what the literature is."

Again, as individuals whose jobs are to support faculty and administration in the Business School, and as Canvas LMS experts, these participants did not provide many details on themselves seeking out support. In particular, neither participant mentioned any interaction with the **Teaching and Learning Center**.

Summary

As summarized in ***Table*** *7*, I found that participants across academic units most often depended on their **Colleagues** for support, most significantly in the context of Communication. Interestingly, very few participants mentioned using the **Teaching and Learning Center** for any reason at all, and only participants from Communication mentioned a specific **Orientation/Training** program.

***Table** 7*. Academic Unit, University and Other Resources by Participant

Participant	Academic Unit	Leadership/ Support	Colleagues	Teaching Assistants	Orientation/ Training	Teaching and Learning Center	Internet/ Other
P4	Math						
P5	Math			X			
P6	Math	X	X				X
P7	Information Sciences		X			X	
P8	Information Sciences		X			X	
P9	Information Sciences		X	X			X
P10	Information Sciences		X	X			X
P11	Communication	X	X			X	
P12	Communication	X	X		X		
P13	Communication	X	X		X		
P14	Communication	X	X	X			
P15	Business		X				X
P16	Business		X				

Synthesis of Research Question 2 Findings

Knowledge	Resources
All participants had previous teaching experience, providing general **Pedagogical and Student** knowledge. • But this experience provided only limited benefits to participants in Information Sciences and Communication teaching courses for the first time. **Management and Organization** essential to Math and Information Sciences for large courses.	**Course Coordinators** and **TAs** in Math, Information Sciences and Communication. • Varying levels of benefit. **Colleagues** were most identified resource. • Most helpful in Communication. GenEd Communication only unit with formal **Training/Orientation** program. Limited or no use of **Teaching and Learning Center** across units.

At the individual participant level, one takeaway from this inquiry seemed to be the limited benefit of previous teaching or other experience on participants' current teaching responsibilities. Especially in the case of Communication and Information Sciences, despite relevant graduate education and previous teaching experience, in many ways these participants seemed to be starting anew in terms of developing their teaching practices in relation to the particular courses they had recently been assigned Among the many new hires with whom I spoke, only P6 from Math explicitly mentioned having arrived to the institution with previous Canvas LMS experience. Though many participants shared their current experiences of teaching in different modalities, none mentioned any previous hybrid or online teaching experience, let alone any relevant training.

In terms of seeking out and using learning analytics-related resources, these 13 participants were most likely to access their **Colleagues**. However, colleagues often appeared only marginally useful, especially in the case of Information Sciences where three participants teaching the same course seemed to have only minor, if any, interactions with each other. In the GenEd Communication program, because there is a common course shell, and a related **Orientation/Training** program, there seemed to be a significant culture of information sharing, including information about using the Canvas LMS, among faculty members teaching the same course.

Participants from Math and Information Sciences – as well as the Communication participant not teaching the GenEd course – spoke of the range of responsibilities their **Teaching Assistants** had, from creating quizzes and other content to grading student work. While most participants spoke of these assistants' contributions to teaching and managing their courses, especially in terms of grading homework assignments, P10 admitted to being overwhelmed by apparently too many assistants.

Perhaps most striking was the very limited use of the **Teaching and Learning Center** among these participants. While previous Teaching and Learning Center leadership were instrumental in establishing Communication's GenEd course shell design and reporting structure with the College, this work was accomplished at least a decade ago. Otherwise, the two Tenure Track Information Sciences participants both mentioned attending workshops at the Teaching and Learning Center at some point in the past, but neither discussed how relevant these experiences were to their current teaching. P8 from Information Sciences was the only participant to mention grants related to enhancing teaching practices that were available through the Teaching and Learning Center, but this participant considered the requirements too cumbersome for the most recent cycle and did not apply.

Like the previous chapter, having considered participant responses across academic units, I identified two topics with seemingly broad learning analytics-related implications across the institution. These topics included 1) Collaboration and 2) Canvas LMS and Other Tools Training and Support.

Collaboration

Both the Math Associate Chair (P4) and the relatively new Non-Tenure Track faculty member (P6) mentioned work being done to develop or enhance Bridge and other programs aimed at improving student Math outcomes at this higher education institution. While these participants and others working on these new initiatives appeared to be accessing data from across the university, the projects were still being developed and, at the time of the interviews, seemed separate from daily teaching operations in the department. In some ways, this situation was similar to the departmental self-study described by the Assistant to the Chair of the Communication Department (P12), in that this sort of effort to consider current policies and practices, pulling from a range of data sources, to provide an accounting of what is happening in the department, was clearly beyond the confines of regular operations. This example is also reminiscent of the Program Manager (P15) from Business who described how the planning process for a new program would be the first time in "many years" when instructional designers and faculty would work together with a range of data to facilitate the design process, whereas the regular approach, according to this participant, is only to intervene "when there's a problem."

While these glimpses into new, special projects that rely on both collaboration among multiple stakeholders as well as data gathering related to undergraduate teaching and learning seemed promising, they also pointed to a reality across these academic units where harnessing learning analytics and other data to support teaching, program development, and assessment activities had been limited, or even non-existent, at least in recent memory.

Canvas LMS and other Tools Training and Support

One lens through which to consider the complexity of this higher education institution is surely the way the Canvas LMS is used across academic units, courses, and various stakeholders. As mentioned in Chapter 4, all 13 academic unit participants mentioned using the Canvas LMS for at least some of their teaching, course design, or support practices, but how they used the Canvas LMS, and the expertise with which they used it, appeared to vary widely based on participant responses. While participants teaching the GenEd Communication course are provided with a fully developed course shell on which they receive training, participants still noted limited comfort with using the Canvas LMS. For example, P13 described:

> *I'm really feeling my way through it…I think it would be wonderful…to have a course or something about how to use [the Canvas LMS], but it needs to be something where we're not just on our own because that's my problem. Yeah, I'm on my own to figure it all out….I would love to have maybe like a 20-person webinar…where we can have someone who really knows [the Canvas LMS]…can tell us how to use it…We're probably using maybe 10% of its capacity (P13).*

Separately, the Non-Tenure Track faculty member teaching other Communication courses (P14) mentioned how difficult learning the Canvas LMS was for a teaching assistant: "[The Canvas LMS] is very, very overwhelming for her. I've worked with her closely. She's worked with one of the [other] professors really closely on it, too." P14 recognized that the Teaching and Learning Center offers resources on using the Canvas LMS and has encouraged the teaching assistant to use these resources, though it does not seem like the teaching assistant pursued these opportunities, instead depending on support from faculty in the department.

Elsewhere, faculty members were learning how to use the Canvas LMS on their own, and not accessing other resources that might enhance their understanding of the platform or how to use it more effectively. According to the Tenure Track faculty member from Information Sciences (P8) who had taught the same course for multiple semesters, "I'm not a huge fan of [the Canvas LMS] and I find it a bit confusing." One of the Non-Tenure Track faculty new to teaching the same course (P10) summed up this participant's use of the Canvas LMS with, "I'm not doing great." One of the instructional designers from Business (P16) had the following to say about some faculty members' issues with using the Canvas LMS: "I think some people are just unaware of how it all works."

There was also evidence of participants in the same academic unit, teaching the same or similar courses, using the same third-party platform, but using them in different ways, without any discussion, collaboration, or access to other resources, leading to what appeared to be different practices and levels of expertise with those platforms. For example, in Math, both the Course Coordinator (P5) and the recently hired faculty member (P6) mentioned using the content platform Cengage, though P6 had gone a step further and also integrated the platform Gradescope. Participants from Information Sciences mentioned using Jupyter Notebook, but they seemed to be using it in different ways, specifically how they integrated and kept track of student work in the Canvas LMS. In the GenEd Communication course, there was an online textbook with separate multimedia features that are standard to the course shell, though the participants new to teaching the course still seemed to be learning the material, despite having received training. P15 and P16 from Business both mentioned that many faculty members used online textbooks and other resources – which P15 speculated had "really valuable analytics" – but, as instructional designers, they did not have access to these resources and did not know whether or not, or how, faculty were actually using them.

To connect finding from Chapter 3 with findings from Chapter 4, there seemed to be a wide range of issues limiting more, and better, use of learning analytics-related tools and approaches. Despite previous teaching experience, many participants lacked relevant training, worked in academic units with limited information sharing among colleagues, and/or possessed a hesitancy, if not a resistance, to seeking out relevant support, at the Teaching and Learning Center or elsewhere.

In short, my investigation considered a variety of academic unit participants possessing a variety of course design and course management practices across disciplines and courses, coupled with inconsistent access to and use of relevant support and other resources. Cumulatively, the landscape of learning analytics usage at this institution seemed decidedly more chaotic than Dawson, et al.'s (2018) designation of "emergent innovators." Even when compared to others teaching in the same department, the case of the GenEd Communication program appears very much an outlier, with its standardized course shell, its training program, its use of Canvas LMS dashboards including learning outcomes, and its reporting structure. Elsewhere, participants were clearly engaging with learning analytics-related tools and approaches, but their related practices appeared random and sometimes needlessly idiosyncratic. Despite a clear commitment to the success of their students, and a general commitment to evidence-based teaching, participants across academic units clearly wanted, and needed, additional support and access to relevant data to enhance their course design, teaching, and other responsibilities. With this understanding of this particular institution, my next step was to present my findings to members of campus leadership and determine a path forward.

Chapter 6: *Research Question 3* Findings

How might institutions leverage and support current learning analytics structures and practices?

With my first research question, I established that participants at this higher education institution were engaged in a range of learning analytics-related teaching and administrative practices, with significant variability between not only academic units but also participants in the same academic unit, even those teaching the same course. With my second research question, I established that these participants had a range of backgrounds and general approaches to teaching, as well as a range of access to, and actual use of, resources across the institution and beyond. Consequently, the image that has come into focus is that of an institution where teaching practices in general – and teaching with learning analytics-related tools and approaches specifically – emerge from the ground up.

Among the several topics presented in my synthesis of responses from the 13 academic unit participants, I chose three learning analytics-related areas that seemed to have broad relevance for expansion and improvement within and across academic units at this higher education institution: 1) Canvas LMS and other Tools Training and Support, 2) aggregate learner and course management data, and 3) learning outcomes assessment. With these three areas in mind, I then interviewed the Math & Sciences Assistant Dean (P3) as well as the Teaching and Learning Center participants (P1, P2), to gain further insight from these College and University leaders and to identify potential efforts to address them. These interviews were also semi-structured, with participants sharing some of their backgrounds, current roles and responsibilities, as well at their understanding of and experience with learning analytics-related tools and approaches.

Canvas LMS and other Tools Training and Support

The Canvas LMS is used across academic units, but only one academic unit participant (P6) mentioned any previous experience with the Canvas LMS before beginning to teach at this institution. Moreover, only the GenEd Communication program, with its course shell, provided any sort of relevant training. Even with this training, Communication participants, along with the majority of other participants, all expressed dislike of, frustration with, or a general lack of confidence using the Canvas LMS. Compounding this issue was my finding that many participants were also attempting to integrate the Canvas LMS with other platforms. Given the significant use of Canvas LMS and other platforms for a range of teaching and course management practices, it seemed clear that any goal of strengthening or expanding faculty use of learning analytics tools and approaches must include some attention to providing more and better opportunities for training. Thus, I sought further information on this issue from the Assistant Dean from the College of Math & Sciences, as well as the Associate and Executive Directors from the University Teaching and Learning Center.

The **Assistant Dean** (P3) has worked at the institution for many years and is also the Director of a program connected to the Biology department where this participant also teaches. As an Assistant Dean, this participant is involved with supporting academic units throughout the College, including Math. In particular, this participant oversees an in-house Teaching and Learning Center in the College of Math & Sciences, separate from the University Teaching and Learning Center. As part of the interview, I asked if the College provided support related to using the Canvas LMS. The Assistant Dean described the

Center's limited resources and their general approach of pointing faculty to other campus entities:

> *So we try not to duplicate efforts, and…[the Division of Information Technology] and [the University Teaching and Learning Center]…have a lot of resources for that. Our center is…one full time staff person and a half-time grad assistant…We are bare bones and we try to provide more of the kind of conceptual support and connecting people with…resources. We do occasionally run workshops like…when COVID hit and everybody had to go online, we ran a whole bunch of workshops…A variety of things. But we don't provide technical support, especially if it's a situation where we can say…call this number or go to this website (P3).*

Going a step further, I also asked this participant if there had even been any assessment activities around determining faculty use of the Canvas LMS. The Assistant Dean noted the benefits of consistency across teaching practices, but explained that the College was not in a position to make any specific requirements:

> *I think that's pretty much beyond the scope of what we're thinking about…You know, I can see there are lots of benefits to getting some consistency in use of [the Canvas LMS] across the College…For our new grant [on] inclusion and equity, using [the Canvas LMS] would help in a lot of cases where students don't know what their grades are, or they're…not sure how to…interpret, you know, what's required of them in the class. [The Canvas LMS] helps a lot, but we can't dictate what faculty do. So, if they have another system that they're using instead, which happens, or they don't use any…learning management system at all…we can't force change on that (P3).*

According to the Assistant Dean, the College appears unable to impose certain teaching practices on faculty, specifically what sort of platform – the Canvas LMS or anything else – that faculty might use to manage their courses. This insight was central to my investigation of change according to a CAS framework like this higher education institution. At this particular institution, or at least in this particular College within this institution, top-down directives or mandates are not merely ineffective; indeed, they appear almost impossible in consideration of the current teaching and learning culture where individual academic units, and individual faculty members themselves, maintain significant autonomy and control over what and how they are teaching.

The **Associate Director** of the Teaching and Learning Center (P2) had also worked at this institution for many years, originally in another academic unit, and only somewhat recently at the University Teaching and Learning Center. In many ways, the evolution of this participant's position seemed representative of the way the Teaching and Learning Center was seeking to change the way it offered services to faculty. The Associate Director explained how the COVID-19 pandemic shifted the organizational structure and overall strategy of the Teaching and Learning Center:

> *When I came on a couple of years ago, I was not supposed to be doing what I'm doing right now…We were only supposed to be… the more technology-enhanced teaching sliver within the [Teaching and Learning Center] at large. And then the pandemic came and everybody quit…And now we are an instructional design slash faculty development unit. And so…it used to be a very academic space where there were, you know, scholarship of teaching and learning and conferences and papers...And now…it's…customer service driven (P2).*

While some of the 13 academic unit participants would have been at the institution to experience some of this evolution, especially the upheaval brought on by the pandemic, many of the participants had been at the institution less than two years, some only a single semester. Nevertheless, this institutional knowledge about the Teaching and Learning Center explains, at least in part, why in the past faculty members might not have felt compelled to seek out Canvas LMS-related or other similar support from the Teaching and Learning Center. In short, that was not the sort of support the Center was focused on providing.

The Associate Director went on to describe the rationale for the new approach that the Teaching and Learning Center was planning, which includes the creation of an asynchronous Teaching Academy that will be available to faculty:

> *My team now has been talking about how to push this further…So one of the things is…making [it so] our service is not contingent on who is in our center at the time is really important for campus. So, Colleges can't require certain trainings because…they weren't consistent enough…So we [now] have a model called the Teaching Academy, which is this kind of 40 course instance with these five tracks with UDL and of course design and technology innovations and antiracist pedagogy, etc…And this will at the bare minimum exist as asynchronous content that people can count on. And then, of course, my staff will continue to do all the…live…face-to-face and virtual versions of those things. But if anybody goes, this will always exist (P2).*

Concerning the issue of when and why faculty members might access these new resources, the Associate Director mentioned that some Colleges are interested in having required training for new hires:

> *I've heard [that]…some of these newer Deans are really interested in having required…initial points of entry for their faculty. If we can give them access and say you can pick if you want them to do, you know, foundations for course design and foundations for entering this pedagogy, then that can be it. Or, someone else can ask for different categories…They can have differentiated content that would be unique for their department that then would always exist (P2).*

According to the Associate Director of the Teaching and Learning Center, it is only recently that this participant and other team members have turned their focus to providing direct services, including Canvas LMS-related training, to faculty and others around campus. Moreover, with the establishment of the Teaching Academy structure, the Associate Director wants to ensure that relevant asynchronous material is available to the campus, regardless of future staffing or other organizational changes that might happen. Moreover, the Associate Director mentioned that some Deans were interested in requiring such training, and that, in the future, training could be tailored to particular departments and programs.

In light of the Math & Sciences Assistant Dean's comment that the College "can't dictate what faculty do," this idea of mandatory training requirements seems to be an alternative approach of guiding faculty in a certain direction, with the hope that new hires will choose to adopt the Canvas LMS and other preferred approaches.

The **Executive Director** of the Teaching and Learning Center (P1) had been hired in the past 18 months, having previously worked at another institution, running another campus entity that was very involved in leveraging data to improve student outcomes. At the previous institution, the Executive Director was very focused on data-driven approaches to improving course outcomes, particularly in introductory STEM programs:

> *STEM seems to be particularly challenging…especially in the Math [and] Chemistry domains, with…Physics, Statistics, Biology …Economics adding some additional challenges. So, I tend to try to figure out how to build tools for faculty, for faculty groups, for department level, and for college level administrators, try to make sense of what's going on in their courses and…point to where there's needs for trying to improve (P1).*

When asked about how this work related directly to classroom-level issues, including faculty approaches to pedagogy and use of the Canvas LMS and other platforms, the Executive Director described the importance of working at the very local level of the academic unit, if not the individual faculty member and course. The Executive Director described a collaborative approach:

> *Let's figure out how to build a community around trying to improve what's going on [in] that course. Maybe have a course coordinator that's kind of in charge of keeping some*

> *consistency, having some shared assessments, having conversations about pedagogy, having some uniform training of teaching assistants, so building a little bit more of that into the system (P1).*

With this response, and given my previous interviews with academic unit participants that provided descriptions of interactions with course coordinators, I asked more about how this effort was going. The Executive Director provided the example of Math, where, according to the Executive Director, current course coordinator roles do not possess the necessary authority to be as effective as possible:

> *So, what I've learned about how Math is set up is that every semester somebody gets tapped on the shoulder for, "Hey, you're the coordinator for this semester for this class"…And what that means is you wrangle questions from people for the exams, and you kind of put those together and…that's pretty much the main thing you're supposed to do…There's no real…coordination role. There's no true...training role…When I asked Math if that role had any power, I was told,…"Of course they don't. Oh, why would they?"...It's just this burden that, you know, people get attached with (P1)*

According to the Executive Director, work needs to happen at the academic unit or even course level, and specific roles, like course coordinators, need to be in place to ensure both training and consistency across courses. While recognizing that the role of course coordinator already exists in some academic units like Math, the Executive Director confirmed that these roles currently have few of the responsibilities they need in order to be more effective.

Considering these responses altogether, there are a range of issues that need to be considered, many of them related to personnel. First is the role that Colleges have in providing or requiring faculty Canvas LMS training and support. Even with its own Teaching and Learning Center, the College of Math & Sciences currently does not have the capacity to provide Canvas LMS or related training, nor does it have the ability to require departments or their faculty members to use the Canvas LMS in any specific kind of way. As a centralized campus resource, the University Teaching and Learning Center, after a staffing upheaval brought on by the pandemic, is only now in the process of creating asynchronous content that might provide a foundation for teaching faculty on the campus. In the future, the Center might also be able to provide differentiated, tailored content or training pathways across disciplines or academic units. Though the Associate Director mentioned hearing that some Deans might be interested in having required trainings for new hires, the overall Teaching Academy approach, as described, will still require faculty to seek out such training on their own. While this effort might provide a collection of relevant resources that have not existed before, according to the Executive Director, it seems that in many academic units, for real impact, it will require personnel with significant training and coordination responsibilities to lead these efforts.

Aggregate Data

Overall, Tenure and Non-tenure Track faculty participants had little, if any, access to or awareness of any aggregate or historical data related to the courses they were teaching or the academic units to which they belonged. In the case of the Math Bridge programs, the Communication Department self-study, and the new Business program being developed, there were some recent efforts to gather and integrate a range of data. But all of these projects seemed to be very much in their early stages and somewhat anomalous in relation to regular teaching and administration practices within these academic units. Considering the benefit that many participants attached to the possibility of accessing aggregate data, and the relative lack of this sort of data across academic units, I discussed relevant policies, projects, and tools during my interviews with both the Assistant Dean and the Executive Director.

The **Assistant Dean** mentioned responsibilities including grant writing and supporting undergraduate education, for which the College of Math & Sciences takes "a very evidence-based approach to everything we propose, which involves analysis of data on student success…I like to take a…data-informed approach to understanding…all the issues involved" (P3).

In consideration of these projects focused on student success, I asked about when, if ever, Canvas LMS data is involved. The Assistant Dean mentioned a variety of previous projects that used Canvas LMS data in part to determine the impact of an intervention on student outcomes:

> *We do have some projects…where it's a specific instructor or group of instructors…doing something some sort of academic intervention…trying a new technique, and in those cases we have used [Canvas LMS] Gradebook data, yet we haven't gotten that directly from [the Canvas LMS] because…it's in partnership with the instructor… We try to look and see whether…the intervention is linked with changes that we can see and in particular assignments or particular exams (P3).*

Pressing further on this topic, I asked for more details about how faculty members were involved with gathering, analyzing, and reporting data. The Assistant Dean mentioned a high level of variability, that, "it differs depending on what the project is. Some of the larger scale things I do myself and then…we figure out ways to communicate the findings of that back to…the relevant level…So that that could be the Chair and the Director of Undergraduate Studies for a particular department." In these cases, there is a gathering and synthesizing of a range of aggregate data, but faculty are not involved. But for smaller-scale projects, the Assistant Dean explained that "it's more collaborative with the instructional staff of that course, working in partnership…to figure out what they're going to measure, how they're going to measure it, and then…communicate it…Usually…it's a bottom up…grassroots kind of thing."

With the example of a current grant project, the Assistant Dean discussed the complicated nature of sharing data with faculty, who in some cases may not be inclined to trust the available data:

> *The data is good because faculty love data, and so they find it very compelling. But it also doesn't prevent pushback...Sometimes when you hear something for the first time, that's not kind of…what you thought it was…[one reaction] is to criticize the way the data was collected or the way the data was analyzed, or whether the data is actually generalizable or is a sample size…[But if the data] was all wonderful, we would have nothing to talk about.*
>
> *The more targeted grass roots kind of efforts are easier because, you know, there's already a self-identified group that's interested in changing something and you're just kind of helping with…how do you measure whether that change has occurred and how do you…push that change along? For the bigger things, they tend to be more systemic. They're much more complicated…people have more to lose if…change happens. Change takes energy and time and money…So, it's hard (P3).*

According to this Assistant Dean, there are obviously a range of efforts throughout the College of Math & Sciences that leverage a range of data, including some course-level Canvas LMS data. As one way of organizing these projects, on one side are large-scale projects for which faculty members may have little or no involvement, and the Assistant Dean and other leadership are collecting, analyzing, and reporting data among themselves and/or grant funding agencies. On the other end of the spectrum, there are smaller-scale projects focused on individual or small groups of faculty members – usually, if not always, initiated by these faculty members – resulting in a collaborative effort between these faculty and the Assistant Dean to collect, analyze, and report data. According to the Assistant Dean, some of these smaller projects are easier because faculty are already on board and want to address certain issues. On the other hand, larger projects which might have a systemic impact, can generate more pushback, especially when they might result in the need for change.

The **Executive Director** of the Teaching and Learning Center provided much insight into the potential issues related to generating and sharing a range of data. To start, the Executive Director shared some examples of projects being developed for different populations including faculty, department chairs, and College leaders:

> *I'm also working on something…that's trying to provide some information to faculty. Our initial piece is a fairly straightforward one, and it's trying to help me figure out when are your students most likely to be available for office hours based on what other courses they're taking. That's like a really simple thing that we're trying to do. Another thing that I'm trying to do is bring a tool that allows department chairs and college leaders to look at flows of students through their majors. And we're also trying to bring together a tool that looks at…program structures…what requirements are there in courses, what are students…taking to meet those requirements, and which courses in that pathway might have too long of a path of prerequisites and core requisites that it makes it…a stumbling point in a program (P1)*
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According to the Executive Director, the goal of these programs is as much about changing the culture around data sharing as it is about tackling these specific issues. The Executive Director described wanting to not only enhance the capacity of the institution to provide faculty with data, but also change the campus culture around accessing these data. The Executive Director described:

> *trying to build some of the infrastructure…and also just build the…desire and taste of people to have this type of information,…and showing them…that when faculty get data*

about their courses, it's not going to lead to riots…But there is a…fear, which I think has merit, and which is that…a department or a tenured promotion committee or…some administrative group could be looking at the data and using it as a way to say,…"You're not doing a good enough job, therefore you don't get rehired or you don't get that promotion," especially for [Non-Tenure Track faculty]…Or it might say…" Your faculty member are not doing good enough in your teaching." Those kinds of worries…have a basis in some reality…They're not completely artificial. And so they have to be attended to and paid attention to (P1).

Because several of the academic unit participants I interviewed had mentioned their interest in, and the importance of, such data, I asked the Executive Director about the origin of this perception that certain data might negatively influence hiring or promotion practices. The Executive Director answered, "It's been voiced by some faculty that I have interacted with. And…we've had to take special precautions. And many of the tools that I've been involved with to kind of say, 'This is an acceptable use, this is not an acceptable use type of scenario,' and also make it so that…data about the course that you teach…is only…meant for you."

I then asked specifically about aggregating data across a single course taught by multiple people, and the Executive Director mentioned that the situation really depended on the nature of staffing certain courses.

It's not too tricky when you have…three or more people that routinely teach a course. You can figure out ways to…share out the appropriate elements with each person…But when you have courses that…[in] the fall is always taught by person X and [in] the spring is always taught by person Y, then that can create some issues with how you can share …The challenge…is that it's pretty common for us to want to do comparisons. Like you find out that it's normal for minority students to have a half grade lower in the course you're teaching. You want to know, "Am I normal? Am I doing better, or am I doing worse?"...And if you're… the instructor that's doing worse, that's going to be used against you. On the flip side, if you're the [other] instructor, you *think, "Hey, I should be able to use this to show that I'm doing a better job?" And then the others will say, "Well, that's not fair. You're just giving out easy grades"…Those types of comparisons start this whole chain of…nonproductive conversations…It seems to be less productive than when you just figure out, like in my own class, this is happening (P1).*

Elaborating on this issue of productive and nonproductive conversations, the Executive Director provided the example of addressing the issue of outcomes for female students, ultimately arriving at the position that it is often more beneficial for faculty to consider and reflect on their own teaching practices rather than comparing to others:

I've spoken to some faculty who are really trying hard to make sure that women succeed in their class, and they're finding that men are still doing substantially better in their class than women….So what am I doing? How am I to structure…what's going on?...You might be doing a lot for women, but when…your female students are with a male [teacher], some things go worse than if they're with a female teacher…You start to see some of those patterns. But all of these require deeper investigation…It's rare that we put the time and effort to try to investigate these things more deeply…And it always seems to be more productive to also compare yourself with yourself (P1).

Again, many academic unit participants mentioned having no access to aggregate or historical data related to the courses they were teaching, though they recognized the benefit of such data to determining the overall effectiveness of their courses. New instructors in both Information Sciences and Communication, all teaching courses that have existed for years, were not aware of any aggregate grades or other data related to their courses. New programs in both Math and Business seemed to have recently provided opportunities to gather and consider these types of data, but these projects were still in their beginning stages and seemed outside of the norm within these contexts.

While both the **Assistant Dean** from Math & Sciences and the **Executive Director** from the Teaching and Learning Center both professed their own data-driven approaches, and mentioned multiple new projects and initiatives, they also identified a range of concerns and competing perspectives regarding the use of aggregate data, all of which speaks to what might be considered, at best, a certain culture of skepticism relating to data throughout this institution.

The Assistant Dean noted how some projects tended to be more successful when faculty initiate the projects or are involved from the very beginning. Therefore, one important bottleneck seemed to be providing faculty with sufficient motivation and resources to pursue the kind of projects that would prompt them to collect and analyze relevant course data in order to make decisions about areas that might need improving. Tackling this bottleneck seems synonymous with the more general culture shift surrounding data usage which the Executive Director expressed being committed to facilitating across campus. While one participant from Information Studies mentioned having recently wanted to apply for a grant through the University Teaching and Learning Center to conduct course-related analysis and development, this participant described the application process as too difficult. Considering the Assistant Dean's description of successful projects, it seems that opportunities for this sort of work might be most successful when they are initiated within the academic units themselves.

Learning Outcomes Assessment

As discussed, the GenEd Communication program has a longstanding commitment to learning outcomes assessment, which depends on functionality including a dashboard built into the Canvas LMS. In contrast, participants from other academic units, while alluding to the importance of learning outcomes and other assessment, mentioned a general lack of these activities. To address this divide, I discussed relevant policies, projects, and tools related to learning outcomes assessment during my interviews with the Assistant Dean, the Associate Director, and the Executive Director.

As the **Assistant Dean** described, “I'm the point person for learning outcomes assessment within the College. And before that I was on the committee that helped write the reports for…Biological Sciences.” With this background, I asked about specific learning outcomes assessment practices across the College, to which the Assistant Dean responded that it varies significantly across academic units:

> *It's very siloed at the moment and…some departments are doing a fantastic job and I see that mostly with newer programs that had the right learning outcomes at the very beginning. And because of that, their mindset is a lot different. Some of the departments that have, you know, been teaching a particular subject since pre-history. Right. It feels like a very administrative exercise that has no value to the department…So we have that, you know, real spectrum of…how people feel about learning outcomes (P3).*

I asked why some departments pursued learning outcomes assessment practices and others did not, and the Assistant Dean mentioned the influence of accrediting agencies:

> *We don't have accreditation for any of our majors. So, it's not like Engineering…[or] Education or Business, where they're always thinking about…what are we supposed to be doing according to our accrediting agency, and are we doing those things? And they have to be measuring very regularly. We don't have that with any of our majors. So, it really feels to a lot of departments like it's something extra and it gets very siloed (P3).*

When asked about ways that learning outcomes can be assessed, the Assistant Dean mentioned, "I know there are ways within [the Canvas LMS] to specify learning outcomes and get the data…I don't think we have any departments that that are engaged in that at all."

Thus, according to this Assistant Dean, attention to learning outcomes is very uneven, with many departments in the College of Math & Sciences not feeling compelled to pursue such practices when they are not attached to external accreditation. Despite the Assistant Dean serving as the point person for learning outcomes assessment in the College – with a history of supporting, and an apparent belief in the benefit of, learning outcomes assessment – this commitment not appear to be a widely shared view, and other leaders in the College either do not have the resources to conduct learning outcomes assessment or do not see recognize how these sorts of assessments might contribute to student learning. Moreover, even among those departments who are pursuing learning outcomes assessment in the College of Math & Sciences, no one is using the Canvas LMS to do so.

According to the **Associate Director**, the Teaching and Learning Center also offers assistance with learning outcomes assessment practices: "If people want to think through their learning outcomes assessment, or if they want to think through…how the vertical articulation of certain courses lead to other courses…that kind of more comprehensive help." When asked about how developing learning outcomes assessment is going across the institution, P2 explained it has been a relatively long process, resulting from a shift in "culture around the fact that it's okay for programs to have required [learning] outcomes. So, we're coming a long way. But now the idea of to assess and how to assess is…really, I think, in its…infancy."

To describe how precarious learning outcomes assessment can be, the Associate Director provided the example of an academic unit at this institution that had a highly developed program for a time, but then its resources were pulled, and a new Dean eventually ended the program. In this academic unit, the Associate Director explained, there was:

> *this beautiful process where they trained the TAs and…they had these rubrics [for]…the outcomes…that they were specifically targeting…They would go in and do their…scoring of the rubric…, and they would aggregate those data. And they had this kind of really nice assessment. Then they would get the feedback to the course coordinator…And then the new Dean came in and removed that whole team, and that whole team left. And now they …handed it to an instructor that didn't know anything about the process. And the last two reports have been like just chaos. And then they just chose to not continue it. So even when it's going well, it's not going not necessarily going to continue (P2).*

When asked about why this academic unit had set up this learning outcomes assessment process in the first place, the Associate Director confirmed that it was for external accreditation:

> *[The person in charge of the accreditation] who really spoke with the Dean at the time and said, you know, we need this for accreditation. We need a person who's dedicated to do this and do this well. And [the Dean]…trusted [the person in charge of the accreditation] …So,… a lot of these programs that have these external accreditation will often say we do [learning outcomes assessment] for [the accreditation agency], and that's enough…[whereas other programs think such activity is] silly and superfluous (P2).*

Considering these responses, it appears that the University Teaching and Learning Center currently has the personnel and expertise to provide support to faculty and programs with learning outcomes assessment efforts, if faculty and programs request this assistance. Like the Assistant Dean, the Associate Director mentioned the relationship of external accreditation with learning outcomes assessment. Yet, with the example of another academic unit, the Associate Director showed how changes in leadership can shift priorities, and how changes in staffing can limit, or even end, the capacity to do so.

The **Executive Director** mentioned being very involved with developing learning outcomes assessment practices at a previous institution but had not yet been involved in this effort at this institution. Nevertheless, the Executive Director noted a strong commitment to learning outcomes:

> *Learning outcomes are…critical. The act of engaging the faculty, teaching an introductory course in a meaningful discussion about what it is that is important to be covered in the course. And then getting some kind of agreement on that. And then supporting them…to ensure that that's how their course is structured. That's where they're spending the majority of their time to achieve those primary objectives. I think that's really valuable (P1).*

Despite the value of this activity, the Executive Director confirmed that is comes at a cost, and requires an incredible commitment from those faculty and others who are directly involved with individual courses:

> *I think each step in that process is painful to most faculty…I haven't seen very many positive instances of what the reward is for doing that, other than just being a good instructor who cares about their students...I used to run the division like how to compensate people for their time to have done that or giving them the time to do it or giving them space to do it… Teaching and Learning centers can help you guide you through the process…But most of the time they don't know the content that you're dealing with. And so often [Teaching and Learning*

> *Center staff are] reticent to do this and they just tell you, well, here's what you're supposed to do…But I found that in a lot of STEM departments…they really need somebody to guide them through the process…be with them and suffer with them (P1).*

Complementing the Associate Director's response, the Executive Director also believed that Teaching and Learning Centers can have a role to play in supporting the development of learning outcomes assessment practices across disciplines, but that faculty members must be involved in the process. Moreover, given the time and effort required, the Executive Director also raised the issue of needing to clearly articulate the value of these practices, and, potentially, to compensate faculty members in a meaningful way.

Synthesis of Research Question 3 Findings

	Assistant Dean	**Associate Director**	**Executive Director**
Canvas LMS Training/ Support	In-house Teaching and Learning Center does not have adequate resources. College of Math & Sciences cannot impose practices.	Pandemic and organizational change caused disruption in Teaching and Learning Center. New Teaching Academy being developed.	Course coordinators and other academic unit personnel need resources and authority.
Aggregate Data	Smaller projects originating from faculty are easiest. Larger projects leading to systemic change receive more pushback.		Some concern that access to data will be misused. New tools being developed to change culture around data.
Learning Outcomes Assessment	Inconsistent LOA practices across College, related to accreditation.	Teaching and Learning Center has personnel to support LOA. Inconsistent LOA practices across institution, related to accreditation.	LOA difficult but important. Requires a partnership between Teaching and Learning Center and academic unit personnel.

Based on responses from the 13 academic unit participants, this chapter started with the understanding that faculty and staff recognized the importance of, if not their own personal desires for, 1) additional support and training related to their use of the Canvas LMS and other platforms, 2) aggregate data related to the courses they were teaching, and 3) learning outcomes assessment practices to better determine what students were actually learning in their courses.

The Assistant Dean and the Associate and Executive Directors similarly recognized the importance of these areas, noting significant inconsistency in related support structures across academic units, and an overall need for the campus to grow and evolve in its intentional use of relevant data. Most significantly, these participants noted the various ways in which these efforts must be grounded in the local educational contexts of academic units, if not the individual courses and the faculty who teach them. Some structures and practices seem to be in place, but they will require significant strengthening and further investment.

For example, the College of Math & Sciences has its own Teaching and Learning Center, but they do not have the capacity or resources to help its faculty with essential competencies such as using the Canvas LMS or other relevant platforms. The position of course coordinators exist across academic units, but they do not seem to currently possess the resources or authority to manage and provide direct support including training to their faculty members in a more meaningful way. Business has its own Instructional Designers with Canvas LMS expertise and a commitment to learning analytics-informed course design and management practices, but these positions seemed under-utilized and even cut off from the faculty, programs, and courses they were supporting. The University Teaching and Learning

Center was planning a new approach to providing asynchronous training content, with some potential options for tailoring to certain disciplines. However, it remained unclear how to ensure faculty would actually use these resources.

Some academic units have developed learning outcomes assessment practices, including the GenEd Communication program that uses Canvas LMS assignment rubrics and dashboards to enable this process. Moreover, both Colleges and the University Teaching and Learning Center have at least some personnel to support learning outcomes assessment practices. But a commitment to this assessment was highly uneven across this institution, including how the assessments were designed and conducted, and, more significantly, whether or not assessments were being done at all in some academic units. In most cases, learning outcomes assessment was linked to accreditation requirements rather than a desire to determine what in fact students are learning in their courses.

Chapter 7: Discussion

In the previous chapter, I presented findings from my discussions with three College and Teaching and Learning Center stakeholders on the topics of Canvas LMS and other Tools training and support, Aggregate Data, and Learning Outcomes Assessment. Focusing on these three topics was, most importantly, a way of sifting through highly variable learning analytics-related teaching and learning practices across these academic units and arriving at specific areas where there appeared to be broad relevance across this particular higher education institution. Rather than leaning into “learning analytics for the sake of learning analytics,” these three areas represent aspects of teaching and learning to which a variety of stakeholders at this institution attach significant meaning and value.

Based on my interviews with these three participants, I used Ueland, et al.’s (2021) CAS Framework for Higher Education to develop CAS-informed recommendations on how to work towards learning analytics goals across these academic units and the institution. Ueland, et al.’s (2021) concern for CAS principles related to an initiative called Equity 2030 “that will require changing the culture of the whole system by embedding equity-mindedness in every aspect of Minnesota State” (p. 131). In this study, the Equity 2030 initiative served as an “Attractor,” which the authors describe as the impetus for a “strategic leadership CAS based framework that may lead to emergence and co-evolution to a new, more equitable state of being” (p. 123). In the case of my project, I have also attempted to outline CAS-based recommendations that might create, improve, or strengthen learning analytics-enhanced approaches to undergraduate teaching and learning at this particular higher education institution.

CAS-Based Framework and Recommendations

In the following sections, I define and then apply the concepts of Networks, Nonlinearity, Self-Organization, Feedback Loops, and Path Dependency, before returning to the concept of Emergence for a summary of the chapter.

Networks

Ueland, et al. (2021) assert that, within the context of higher education, “formal and informal networks abound. Faculty exists within professional departments (Mathematics, English, etc.), and staff work within commonly recognized and defined departments (Student Affairs, Information Technology, etc.) within institutions” (p. 125). At this particular higher education institution, there are many networks, representing many information channels. The 13 academic unit participants highlighted numerous networks through which information was shared between and among teaching faculty, teaching assistants, support staff including instructional designers, course coordinators, program directors, Associate Chairs and Chairs. According to the Assistant Dean of Math & Sciences, there were also separate networks between the Dean’s office, department Chairs and program directors, networks between the Dean’s office and other University entities, as well as networks between the Dean’s office and faculty members. According to the Associate and Executive Directors of the Teaching and Learning Center, there were additional networks between the Teaching and Learning Center and both College and Departmental leadership, as well as networks between the Teaching and Learning Center and individual faculty members.

Based on participant responses, there were significant issues with some of these networks, especially in the very local context of specific academic units. Some of these network problems include limited course coordinator roles (e.g., Math), limited colleague-to-colleague interaction (e.g., Information Sciences), limited support staff and faculty interaction (e.g., Business). Beyond these local contexts, there also seemed to be limited interaction between College resources and teaching faculty (e.g., Math & Sciences), not to mention the limited interaction any of these participants had with the Teaching and Learning Center.

In all, this higher education institution is a complex web through which learning analytics-related and other teaching and learning information is, or might be, shared, with no single network – in particular, no singular, top-down network – providing uniform information across stakeholders. Among the academic units considered, Communication seems to have achieved the most integration and cohesion among various stakeholders, with teaching faculty having access to each other and to programmatic leadership, and programmatic leadership having consistent engagement with College leadership.

Nonlinearity

According to Ueland, et al. (2021), in higher education, where numerous networks contribute to uneven and inconsistent information sharing, “nonlinearity may contribute significantly to evidence-based best or promising practices failing when replicated for any number of scenarios, despite implementation integrity” (p.128). Importantly, nonlinear relationships can mean that “small actions can have large effects and large actions can have virtually no effect” (p. 127). Given this reality, leaders in higher education institutions find more success when empowering those stakeholders who are most directly connected to the local context, in contrast with depending “on rigid compliance or micromanagement strategies” (p. 128).

Considering the variety of ways teaching and learning was happening across these academic units, and the specific networks that characterized each local context, Ueland, et al.'s framework suggests that this institution should focus on promoting learning analytics-expansion within academic units, recognizing that outcomes will necessarily be different based on the myriad issues at play. This general approach is supported by all three of the College and University leaders.

For example, the Assistant Dean noted the success of smaller-scale projects that depended on aggregate data: "it's more collaborative with the instructional staff of that course, working in partnership…to figure out what they're going to measure, how they're going to measure it, and then…communicate it…Usually…it's a bottom up…grassroots kind of thing" (P3). For the Associate Director, Canvas LMS and other training materials should be tailored to individual disciplines: "They can have differentiated content that would be unique for their department that then would always exist" (P2). In terms of developing learning outcomes assessment mechanisms, the Executive Director stressed the importance of a relationship between the Teaching and Learning Center and the faculty actually teaching the courses: "Teaching and Learning Centers can help…guide you through the process…But most of the time they don't know the content that you're dealing with" (P1). In short, both College- and University-level stakeholders can play important roles towards providing academic units and individual faculty with resources and expertise, but how these resources and expertise are used, and the results of these partnerships, will likely be different across contexts.

At issue among these academic units and, perhaps, throughout this institution, are new, limited, or otherwise under-utilized resources. According to the Assistant Dean, the

College of Math & Sciences has its own Teaching and Learning Center, but it has limited staff and is unable to provide direct support to faculty members. According to the Associate Director, the Teaching and Learning Center underwent staffing changes and a re-organization, and has only recently shifted its approach to how it provides resources across the University. According to the Executive Director, and as discovered through my interviews, course coordinators in Math and elsewhere exist, but they do not have the profile or resources to provide the essential training and coordinating duties that would better ensure things like consistency across courses and training on the Canvas LMS and other platforms.

In some ways, the recently created Executive Director position, and the re-organization of the Teaching and Learning Center, are representative of a CAS-based approach to leadership, very similar to what Ueland, et al. describe in terms of Minnesota State. For the Equity 2030 project, "a 'chaotic' element was created in the form of a Senior Director of Strategic Initiatives…By creating an intentionally boundary-spanning position…the Chancellor introduced an agent who could, in theory, work across the various Divisions, creating space and opportunity for inter-network communication, intentional collaboration, and more integrated communication which promotes the creative and chaotic energy that is needed to tilt towards a new emergent state" (p. 133). Rather than a single agent from whom all information and mandates flow, this Director of Strategic Development at Minnesota State seems very similar to the Executive Director position, with a goal of moving across contexts of the institution to determine local needs and facilitate interaction and information flow throughout the system.

Self-organization

In some ways, self-organization can be considered an outgrowth – even an expected, necessary dimension – of complex systems defined by an abundance of networks and nonlinearity. As change happens, as new initiatives emerge, so, too, do new alliances, in the form of committees and other shared governance bodies. For Ueland, et al. (2021), “Leaders within higher education must take an active role in understanding how limiting variation in activities that promote self-organization and co-evolution can inhibit the ability of their institutions or systems to adapt and evolve in positive ways. (p. 128). Rather, leaders should expect and allow for, and even prioritize, shared-governance bodies to emerge in order to facilitate change.

Participants mentioned a range of new, promising initiatives. All Information Sciences participants teaching the Introductory Programming course mentioned an upcoming project that seemed to be the main catalyst for interaction between these colleagues who otherwise operated independently. In the GenEd Program, the Co-Director explained that the Co-Directorship was created in order to share leadership responsibilities with a Non-Tenure Track faculty member. The Bridges program and other work being done in the Math department had created opportunities for the newly hired faculty member to engage with Departmental leadership and others across campus. Even a new Master’s program in Business had created an opportunity for faculty and instructional designers to collaborate in a way they had not before. At a very basic level, these new initiatives represented areas of these participants’ working lives about which they seemed the most enthusiastic, and which they considered as opportunities for change and improvement.

As the Teaching and Learning Center continues to evolve, in all the ways both the Executive and Associate Directors described, one likely outcome will be changes in, if not the creation of, new organizing bodies and other entities within individual academic units which will help to promote change throughout the system. Rather than imposing organizational structures and required compliance mechanisms, this institution should instead provide resources to be distributed within academic units as a means of motivating stakeholders to self-organize.

Feedback Loops

"Feedback loops offer input or communication back to the broader system and are essential for both self-organization and emergence" (Ueland, et al., 2021, p. 129). Simply put, feedback loops are opportunities for agents to discuss and respond to changes in a system. Examples of a feedback loop in higher education include "reactions to a proposed policy change via formal comment processes or discussion occurring in a department meeting" (p. 129). CAS leaders, rather than focusing on how well subordinates comply with mandates, instead "recognize that feedback is an essential part of idea formation and refinement working intentionally to create opportunities for dialogue among agents with diverse perspectives and viewpoints around issues or problems" (p. 129). In terms of the three learning analytics-related areas presented, there are multiple perspectives that require careful consideration.

Canvas LMS training was a significant topic across participants. Among academic unit participants, many were clearly struggling to some degree and wished they had more time, more support, or both. One of the Business Instructional Designers, a Canvas LMS expert, mentioned that many faculty members simply do not know what they are doing. Even in the GenEd Communication program, where a course shell and training are provided, one faculty member described a desire for synchronous, cohort-based approaches to more rigorous Canvas LMS training. While the Associate Director mentioned that the University Teaching and Learning Center would continue offering some face-to-face, on demand support, the main approach going forward would be to provide asynchronous content with opportunities for tailoring according to disciplinary needs. In contrast, the Executive Director mentioned the need to establish, or strengthen the role of current, course coordinators or other personnel who can provide necessary training within academic units.

The issue of aggregate data, specifically the collection and analysis of student and other performance measures across multiple semesters, was perhaps the most contentious subject. Participants across academic units noted their interest in, and the benefits of being able to review, such data; however, the Assistant Dean confirmed that for many projects in the College of Math & Sciences, faculty do not have access to and are not involved in analyzing this data. The Assistant Dean also noted that some stakeholders who do gain access to such data are quick to mistrust the validity of related analyses, especially when they point to something "bad" or unexpected happening in a course or program. Moreover, some stakeholders are hesitant to assemble and consider such data if they might lead to the need for change, which is always time consuming and costly. The Executive Director mentioned issues of faculty fearing that data might be (mis)used for promotion or other decisions, particularly for Non-Tenure Track faculty members. The Executive Director also identified issues that might arise when aggregate data is, or could be, used to compare faculty members.

Among academic unit participants, many expressed an interest in finding more and better ways to clearly articulate learning outcomes to their students, and, ultimately, to assess them. However, the Assistant Dean noted that many departments do not do anything on this front, and feel that such activity is superfluous, especially when it does not relate to gaining or maintaining external accreditation. The Associate Director stated that a commitment to learning outcomes was only in its infancy at this institution, and both the Associate and Executive Directors described the precarity, and difficulty, of assembling the personnel and the processes for doing learning outcomes assessment well.

According to Ueland, et al. (2021), "campus and system leaders who listen both to amplifying and dampening feedback raised from across networks and structures and work to synthesize and mold ideas into practical solutions that align with the high-level strategic vision are necessary to lead change" (pp. 129-130). In short, these leaders need to be aware of, and allow for, conflicting perspectives. Since work in these three areas seems to be in their early stages, it is clear that further discussions need to happen throughout the institution, especially with leaders and faculty members in academic units, to determine ways of meetings needs and assuaging fears.

Path Dependency

Especially at this higher education institution, where some of the participants for this study have worked for decades, certain structures, channels, and networks are well established, essential qualities of the institution. Path dependence refers to how these past structures can either help facilitate or else serve as a barrier towards achieving change. As the Assistant Dean noted, systemic change is difficult, and often unwelcome. At worst, according to Ueland, et al. (2021), "The number of seemingly intractable challenges higher education is facing and the apparent resistance to change may be indicators that, as an industry, higher education has succumbed to the inertia brought on by too much stability, making it difficult to innovate in ways that are too far removed from what the system already does well" (p.130).

Yet, the University Teaching and Learning Center is in the middle of what seems to be a major change, with an eye for the long-term future. With the hiring of the Executive Director, and the establishment of the Teaching Academy approach to training and support, there appears to be real momentum, with dedicated resources and political will, to facilitate change that will, in part, promote learning analytics-related expansion throughout the institution.

While other new initiatives abound, as discussed in the previous section, the concept of path dependency provides an opportunity to further consider the GenEd Communication program. In many important ways this program might serve as a model for how other programs might operate, in terms of the culture of information sharing and support it has established among faculty and programmatic leadership, its reporting structure with the College, its training program, and its course materials.

However, this structure might have reached some levels of stagnancy. The Co-Director mentioned that the current structure and reporting system was established almost a decade ago with few changes since. While the program has well-established learning outcomes assessment practices, facilitated through the Canvas LMS, it is unclear how the program, especially its students, continue to gain from these elements, with one participant questioning how useful they are. Again, while a CAS-informed approach to change leadership might identify this GenEd program as a model that has emerged from the chaos, even this model should be subject to scrutiny, through feedback loops and other means.

Towards Emergence

A Complex Adaptive Systems (CAS)-informed approach to change leadership in higher education accepts and harnesses the elements of networks, nonlinearity, self-organization, feedback loops, and path dependency to facilitate and eventually arrive at emergence. For Ueland, et al., "Emergence can represent a new way of doing things or a cultural shift that is tied to the historical foundations and previous work of the organization (path dependence) even though the existing system may already be very well defined" (p. 131). This approach to change in complex systems like higher education institutions marks a fundamental shift from top-down, compliance-focused approaches.

By carefully examining the specific contexts of several academic units through the perspectives of various administrative, teaching faculty, and support staff participants, I was able to map out a variety of learning analytics-related tools and approaches at this particular institution, as well as the personal backgrounds, resources and other elements that contributed to current practices among participants in these academic units. From there, I identified three key areas that resonated across academic units: 1) Canvas LMS and other Tools Training and Support, 2) Aggregate Data, and 3) Learning Outcomes Assessment. I then discussed these topics at length with both College- and University-level leaders, in turn gaining alternative perspectives on these topics as well as additional institutional knowledge.

Armed with these new perspectives and a fuller understanding of the history and structure of this higher education institution, I then used Ueland et al.'s CAS framework to synthesize the whole of my research project into conceptual categories that both depict the nature of complexity in a context like this higher education institution, as well as capture the sorts of values, priorities and expectations that leaders must have in order to enact change that might lead to emergence, specifically in terms of the adoption and further expansion of learning analytics-related activity at this higher education institution. Based on this analysis, I summarize some key recommendations for this higher education institution below.

Recommendations

1. ***Empower and provide sufficient resources to already established academic unit level resources.***

For example, the Course Coordinator appears to be an established role across academic units and well-positioned to provide relevant training as well as to facilitate more regular information sharing and curriculum development among faculty teaching the same or similar courses. Especially in Math and Information Studies, these roles seem to be underutilized, owed to limited authority and, given these individuals' teaching responsibilities that include managing multiple large lecture courses every semester, limited time. If a shared goal is to better prepare faculty, in their use and development of course materials, as well as their facility using Canvas LMS and other relevant platforms – all of which might promote more and better implementation of learning analytics-related tools and approaches – then academic units must reconsider their approach to Course Coordinators and similar roles. These roles must have the authority, time, and resources to fully support the faculty they are intended to serve.

For academic units like Business with their own Instructional Designers, these roles should be more meaningfully integrated into the courses they are supporting. Though tasked with building course spaces and materials for faculty, in many ways these particular participants seemed to be operating at a deficit, not having access to, and therefore unable to analyze and consider the effectiveness of, other content and submission platforms that faculty often integrated into their courses. These Instructional Designers, including a Program Manager, mentioned that only recently were they being included in preliminary discussions regarding the design of an online program. Obviously there are a range of organizational and other issues at play to which this study does not have sufficient access. Nevertheless, with evidence that at least some academic units at this institution already possess in-house Instructional Designers with Canvas LMS and other expertise, surely there are opportunities to further expand the benefit they might provide to faculty and administrators.

The Teaching and Learning Center's current Teaching Academy plan, with a goal of producing asynchronous training materials that might be tailored across disciplines, does seem like it will provide a useful repository of additional reference materials that interested faculty and staff can access. However, if the goal is to ensure that faculty have direct access to the most relevant Canvas LMS and other platform training, then academic unit roles like Course Coordinators and Instructional Designers should, in the very least, be intentionally involved in the development and dissemination of these materials.

A central focus of any training or support mechanism relating to Canvas LMS usage should, of course, focus on course design from the ground up. As mentioned, some instructors were maintaining grading and other essential course materials outside of the Canvas LMS, with these practices owed to their general lack of confidence using the LMS and, in some cases, based on their attempts to integrate other platforms into their teaching. Especially in large lecture courses, instructors and students alike will benefit from consistent, transparent grading practices. Moreover, ensuring that all grading is captured in the Canvas LMS will potentially allow for opportunities for future statistical modeling of student achievement.

2. ***Invest in data aggregation solutions, foster communication, and welcome experimentation.***

At this particular institution, accessing aggregate data related to particular courses, and the students in those courses, over time, seems to be a difficult if not impossible task. Individual faculty members mentioned having no idea about the history of their courses. Instructional Designers from Business mentioned the difficulty of aggregating data based on how courses are organized in the Canvas LMS. Moreover, the Executive Director of the University Teaching and Learning Center, while expressing a desire to enhance data sharing across the institution, also recognized potential negative implications of course data being shared and subsequently evaluated.

The politics and other concerns surrounding the sharing of aggregate data need more careful consideration than what appeared to be somewhat anecdotal concerns. In this case, the promotion of feedback loops seems to be important to moving forward in terms of how to ensure the voices and concerns of stakeholders across the institution are being considered as it relates to making aggregate data more available. Faculty surveys, departmental committees, and University-sponsored forums should be considered as opportunities to determine what types of aggregate data might be useful to which stakeholder populations and for what purposes.

The Executive Director mentioned several initiatives that were under way to develop related tools that will provide a variety of stakeholders with different types of previously inaccessible data. Thus, in some ways, the institution seems to be moving in the direction of creating more opportunities to engage with aggregate data. Nevertheless, there seems to be an opportunity to develop resources that might be shared more widely, with the expectation that there will be different approaches to using these resources over time. This expectation, even this welcoming, of diverse outcomes, is representative of Wise & Vytasek's (2018) Principle of Customization, in particular their consideration of "Adaptable" learning analytics. With long-standing courses serving large student populations especially in mind, faculty, Course Coordinators and other academic unit leadership would surely benefit from having more regular access to aggregate Canvas LMS-generated student activity and performance data beyond final grades.

3. *Establish learning outcomes assessment as an Attractor.*

A clear desire exists among many faculty and staff members to conduct some level of learning outcomes assessment for the classes they teach and support. In the College of Math & Sciences, the Assistant Dean is well-experienced in and committed to the work of learning outcomes assessment. The Teaching and Learning Center has at least some personnel to support these practices, and both the Executive and Associate Directors recognize the importance of learning outcomes assessment. But learning outcomes assessment is woefully uneven across the institution, with some academic units not participating in any related practices, and others only participating to meet minimum accreditation requirements. From the limited purview of this particular study, only the GenEd Communication program had established outcomes assessment practices.

How learning outcomes assessment might be conducted will vary significantly across disciplines and academic units. While the Canvas LMS rubrics and dashboard approach employed by the GenEd Communication program might be equally relevant in additional academic unit contexts, in others it might not. Moreover, with increasing access to aggregate

Canvas LMS and other data, new and richer approaches to learning outcomes assessment are likely on the horizon.

If this higher education institution were to decide to commit itself to promoting a culture of data-driven learning outcomes assessment, then the Minnesota Equity 2030 project, and Ueland, et al.'s CAS framework, provides a foundation. By designating learning outcomes assessment as an Attractor, the University would be committing to the greater goal of expanding assessment practices across the institution. But it would start with the same understanding that there is no one-size-fits-all approach, instead working to ensure that networks and communication channels exist between University, College, and Academic unit stakeholders, and ensuring that these stakeholders have both the motivation and resources to determine approaches that best serve their local contexts.

Establishing an area like learning outcomes assessment as an Attractor at a higher education institution is a complexity science-informed approach to change management that differs from Inputs and other previous learning analytics implementation models. While institutional leadership is integral to articulating a general goal, and communicating its desire to support networks and actors within the institution towards working towards that general goal, institutional leadership is not interested in imposing one certain approach or imposing compliance measures to ensure adherence to a certain approach. Instead, institutional leadership expects, and encourages, a diversity of outcomes, which better represent the local educational contexts of various stakeholders.

Chapter 8: Conclusion

Dawson, et al. (2018) note an important distinction between an “instrumental approach” to learning analytics implementation – representing a “top-down leadership model” espoused by many learning analytics researchers – and “emergent innovators” that represent a “bottom-up model of adoption” (pp. 242-243). Similarly, Doyle & Brady (2018) emphasize that higher education leaders must examine “what is actually happening in institutions” (p. 6). According to what the authors refer to as an *emergent* paradigm, “the analysis of change in higher education shifts to an internal, micro, perspective. Attention is directed to the daily work of the institution and the detail of how academics and others respond to the contextual demands placed on them resulting in outcomes that may sometimes lead to transformational change at institutional level” (p. 6). Seeking to better understand these emergent innovators and paradigms, I immersed myself in complexity science and, in particular, complex adaptive systems (CAS)-informed approaches to change leadership.

From this starting place, my goal was to identify a higher education institution where I could accomplish the digging necessary to determine what stakeholders were doing in terms of learning analytics, and in what specific contexts they were doing them. In particular, I wanted to focus on a single institution, with the expectation that I would find a range of different, potentially conflicting activities across academic units. After identifying a representative institution, I was able to interview a range of participants across several academic units, gaining an intimate knowledge of their backgrounds, their beliefs on learning analytics, and their teaching, administrative and other practices, especially as they related to learning analytics-related tools and approaches. Through these interviews, I arrived at three main topics related to learning analytics, which I then discussed with College- and

University-level leaders who were involved with efforts related to these and other topics across this institution. Finally, with a desire to determine an "emergent paradigm" for promoting change and growth related to learning analytics adoption at this institution, I used Ueland, et al.'s CAS Framework for higher education to synthesize my findings.

Through my conversations with both the Executive and Associate Directors of the Teaching and Learning Center, I was pleasantly surprised to find this institution seemingly in the middle of, or at least the beginning stages of, making some of the inroads and investments into facilitating the expansion of learning analytics that is at the heart of my project. In particular, the Executive Director role, though relatively new, seems well poised to motivate stakeholders across academic units to consider and work towards positive change according to the needs of their specific contexts. Importantly, both the Associate and Executive Directors recognize how context-specific every opportunity for change is throughout the institution, requiring both adaptability and flexibility to meet the needs of different stakeholders.

While optimistic about the path on which this institution seems to be embarking, I was, nevertheless, disheartened to discover how isolated some participants were, with little connection to their academic units or anything else on campus, and little access to support. In some cases, faculty members were teaching courses for which they were obviously not prepared, with large student populations that were difficult to manage. As discussed, many participants teaching large lecture courses were most concerned about the management and organization aspects of their responsibilities, and many of their learning analytics concerns related to how these faculty members might better serve their students by more easily accomplishing certain tasks at scale.

Undoubtedly, providing high (enough) quality, learner-centered teaching at scale is the dream of many a University Financial Officer. But automating basic tasks should not be the only or primary goal of learning analytics tools and approaches. As presented, many participants are deeply interested in finding ways to better understand how students are engaging with course materials, and whether or not students are actually achieving the outcomes faculty members and academic programs say they are supposed to be achieving. These are complicated but essential tasks, no matter the class size.

As discussed, for this embedded case study I was only able to interview a limited number of participants from a limited number of academic units. Moreover, though I attempted to contact multiple College-level participants, including from both Arts & Humanities and Business, I was only able to interview one Assistant Dean from Math & Sciences. Some major finding from my interview with this Assistant Dean included the seemingly limited resources the College of Math & Sciences has to provide support at the individual instructor level, as well as how a lack of accreditation likely influences learning outcomes assessment practices. While my discussions with Teaching and Learning Center representatives corroborated some of these findings, further discussions with other departmental leadership, as well as other College-level representatives, would likely have provided more nuance into what appear to be highly variable resources and practices. An opportunity to meet with representatives from other Colleges would surely have provided even more specific details regarding this variability.

In my Methodology section I noted how the semi-structured interview format was important for gathering nuanced responses from various stakeholders and, eventually, arriving at areas with apparent broad relevance. Moving forward at this particular institution, designing a survey based on these findings would likely be a useful next step, in order to gather more feedback from more stakeholders, especially relating to the areas of Canvas LMS training, accessing aggregate course and other data, and conducting learning outcomes assessments.

I hope that future researchers will be able to take this approach even further, either applying it to another institution to determine similarities and differences between the institution presented in this study, or, perhaps, drilling down even further and examining the various departments and programs from one particular College or School. While some disciplinary differences have been explored in this study, surely there is more to be done on this front. Most if not all of the work of the Executive Director at the Teaching and Learning Center at this institution has focused entirely on STEM departments, which was the foundation for most of our discussion. This was also the case for my discussion with the Associate Director and, of course, the Assistant Dean of Math & Sciences. Since I was unable to connect with leaders from the College of Arts & Humanities or other related departments besides Communication, there remains much to explore among these different communities.

Wise & Vytasek's (2017) Principle of Customization recognizes "that there are multiple, disparate, and equally valid needs and paths (and potentially endpoints) for different learning analytics users" (p. 153). This variability – this sometimes extreme, incalculable variability – was central to my investigation of learning analytics through the lens of complexity science. In a complex adaptive system like a higher education institution, change is important, and change is hard. Identifying a goal and then attempting to enact that goal in a complex system is especially hard. As complexity science researchers argue, setting a standard for a dynamic goal like broader learning analytics implementation, and then monitoring for compliance, is not a reasonable or effective approach. Instead, leaders must understand the nature and organization of the system – what's happening on the ground – must invest in resources in areas that need them, and then expect, and even celebrate, a multitude of outcomes.

Appendices

Appendix A: Semi-Structured Interview

Introduction

Thank you for taking the time to participate in this interview on the topic of Learning Analytics. To start, I want to remind you that you are welcome to answer only those questions you are comfortable answering, and that your responses are for research purposes only and will remain confidential.

Background

To start, can you provide me with some information about your professional background and your current position, as well as your various roles and responsibilities?

Learning Analytics-General

- In your opinion, what is learning analytics, and what is its purpose?
- How did you first learn about learning analytics?

Learning Analytics-Planning

- When did you first decide to investigate learning analytics resources?
- Have you worked with anyone, or used any specific resources, to determine how you might use learning analytics?
- What steps did you take before first using learning analytics?

Learning Analytics-Current Usage

- For what specific purposes have you used, or are you currently using, learning analytics solutions?
- What specific learning analytics tools do you use?
- In what ways has incorporating learning analytics affected your work?
- Has your use of learning analytics been successful? How do you know?

Appendix B: Predetermined Code Book

Learning Analytics Users and Purposes

Student – Bodily & Verbert (2017)

- encouraging awareness or reflection
- recommending resources
- improving retention or engagement
- increasing online social behavior
- recommending courses.

Teacher – Sergis & Sampson (2017)

- analyzing educational design in terms of elements
- capturing the flow of learning and assessment activities
- analyzing learning and assessment activity types

Administrator

- assessing either student or faculty activity or achievement
- determining relevant student or faculty intervention

Teacher Knowledge

Teacher's Knowledge Framework – Fives & Buehl (2008)

- Pedagogical knowledge, including methods and practices, assessment, and motivation
- Knowledge of students, including general knowledge of how students learn details about a teacher's particular students
- Content knowledge, including a specific content area, pedagogical concerns of the particular content areas, and curriculum
- Management and organizational knowledge, related to managing a classroom and organizing tasks
- Self/Other knowledge, including understanding one's own strengths and weaknesses.

Complexity Science

CAS Framework for Higher Education – Ueland, et al. (2021)

- Networks, including faculty groups, senior leadership teams, professional communities, student/faculty interactions
- Non-Linearity, including the strengths and weaknesses of large-scale versus localized initiatives
- Self-Organization, including committee structures throughout the system, self-governance
- Feedback Loops, including range or formal and informal meetings relating to formal and informal structures
- Path Dependency, or constraints, such as established hierarchical channels of communication, and general campus culture
- Co-evolution, interactions of systems, and systems within systems, that promote change throughout

- Emergence, including pilot programs, campus-based initiatives, experimental sites
- Attractor, including a state of which activity and outcomes are drawn

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