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## Rethinking learning analytics adoption through complexity leadership theory

**Citation for published version:**

Dawson, S, Poquet, O, Colvin, C, Rogers, T, Pardo, A & Gasevic, D 2018, Rethinking learning analytics adoption through complexity leadership theory. in *LAK '18 Proceedings of the 8th International Conference on Learning Analytics and Knowledge*. ACM, pp. 236-244. <https://doi.org/10.1145/3170358.3170375>

**Digital Object Identifier (DOI):**

[10.1145/3170358.3170375](https://doi.org/10.1145/3170358.3170375)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

LAK '18 Proceedings of the 8th International Conference on Learning Analytics and Knowledge

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# Rethinking Learning Analytics Adoption through Complexity Leadership Theory

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## ABSTRACT

Despite strong interest in learning analytics (LA) adoption at large-scale organizational levels continues to be problematic. This may in part be due to the lack of acknowledgement of existing conceptual LA models to operationalize how key dimensions of adoption interact to better inform the realities of the implementation process. This paper proposes the framing of LA adoption in complexity leadership theory (CLT) to study the overarching system dynamics. The framing is empirically validated in a study analysing interviews with senior managers of Australian universities (n=32). The results were coded for several adoption dimensions (e.g., leadership, governance, staff development, and culture). The coded data were then analysed with latent class analysis. The results identified two classes of universities that either *i*) followed an *instrumental approach* to adoption - typically top-down leadership, large scale project with high technology focus yet demonstrating limited staff uptake; or *ii*) were characterized as *emergent innovators* -bottom up, strong consultation process, but with subsequent challenges in communicating and scaling up innovations. The results suggest there is a need to broaden the focus of research in LA adoption models to move on from small-scale course/program levels to a more holistic and complex organizational level.

## CCS CONCEPTS

Applied computing~Computer-managed instruction  
Applied computing~Computer-assisted instruction

## KEYWORDS

Learning Analytics adoption, complexity, leadership

## ACM Reference format:

F. Lname, F. Lname, and F. Lname. 2018. Rethinking Learning Analytics Adoption through Complexity Leadership Theory. In *Proceedings of the International Conference on Learning Analytics and Knowledge, Sydney, Australia, March 2018 (LAK'18)*, 10 pages. DOI: [TO BE PROVIDED]

## 1 INTRODUCTION

The field of learning analytics (LA) is positioned at an important juncture in its development. On the one hand, the breadth, quantity and quality of related multidisciplinary research continues to expand. All indications suggest that the field is continuing to flourish and is receiving wide recognition and funding opportunities. This growth is in part due to the perceived potential for LA to address the many systemic challenges often associated with contemporary models of education [8]. However, on the other hand, the rapid growth and diversity of research is also contributing to a deepening and broadening chasm between the research findings and how these outputs are best translated into organizational practice [9]. In essence, there continues to be substantial challenges in addressing how LA can be effectively and efficiently embedded across an organization [27]. The lack of exemplars and resources that can guide institutions in their implementation process represents a significant barrier to systemic adoption [12]. While LA research is rapidly, yet independently, progressing, education institutions remain mired in a quagmire of technical, social and cultural melees [19].

A number of authors have recently articulated various models, instruments and frameworks as an attempt to aid LA adoption processes [6]. Significantly, much of the research underpinning these frameworks and models is conceptual and therefore has not been empirically developed nor tested. While the espoused models diverge in their assumptions and ontological

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LAK'18, March 2018, Sydney, Australia

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DOI: 10.1145/123\_4

framing of LA, there is some consistency in the identified dimensions that are necessary to effect analytics adoption. These dimensions include leadership, organizational culture, technological readiness, staff and institutional capacity, and strategy [5]. Although the existing conceptual work has provided a foundation and impetus for a much needed dialogue and awareness of the factors influencing organizational adoption, it fails to operationalize how the identified dimensions interact in order to better inform the realities of the implementation process.

Drawing on complexity theory, this paper presents and unpacks a leadership model for LA implementation to provide a more nuanced understanding of the factors impacting on organizational uptake. By framing the paper in complexity leadership theory (CLT) [29], we offer new perspectives on the organizational adoption of analytics by examining the overarching system dynamics in lieu of a more general analysis and conceptualization of the individual componentry. To achieve these aims, we first unpack the literature related to analytics adoption models and frameworks before providing a background in CLT. The paper then describes an empirical study designed to identify evidence of complexity leadership in organizations presently adopting LA in the Australian higher education context. The findings revealed two discrete classes of institutions related to how CLT dimensions manifest through institutional practices designed to embed LA. Based on these findings the paper unpacks several suggestions that serve to better understand the dynamic nature of institutional LA deployments.

## 2 LA ADOPTION MODELS

There has been much written regarding the difficulties associated with scaling LA research and outcomes within education settings. As well noted in the early works of Goldstein and Katz [13], Bichsel [3], Ferguson and colleagues [11; 12] and Macfadyen and Dawson [19], the pace of adoption of analytics within education organizations can be categorized as at best sporadic, and at worst resistant. This is further evidenced in the recent reports by Colvin, et al., [6] and West, et al., [31] explicitly examining the uptake of LA in Australian higher education. Critically, Colvin et al., [6] noted that while all senior university administrators listed LA as of a high strategic priority within their organization, few were able to demonstrate widespread scalability of adoption. Ferguson et al., [12] have argued that this is due to the relative immaturity of the field. However, even the ability to demonstrate basic reporting of student learning management systems (LMS) interaction data was confined to a minority of institutions. Clearly, there are a complex set of factors at play that are militating against institutional uptake and adoption. The extant LA implementation models and frameworks can be classified into three primary groups [5; 6]: learning analytics input models; output models; and process models.

### 2.1 Input models

The majority of the prior work in LA adoption has been related to Input models. This category describes LA adoption as a set of

antecedent affordances that collectively underpin the requirements necessary for large-scale implementations. For instance, Bichsel [3] developed the EDUCAUSE Centre for Analysis and Research (ECAR) Maturity Index incorporating a prescribed set of input factors. These factors are ranked on a maturity scale and include: Culture/ Process; Data/ Reporting/ Tools; Investment; Expertise; and Governance/ Infrastructure. In a similar vein, Arnold, et al., [2] established the Learning Analytics Readiness Instrument (LARI) noting dimensions such as Data; Culture and process; Governance; and Infrastructure. Although the dimensions strongly reflect the earlier work of Bichsel [3], an important distinction lies in the framing of the instrument. Bichsel's [3] work serves as an evaluation of current state while the Arnold, et al., LARI instrument was developed as a tool to identify the types of factors that need to be considered as part of any successful institutional implementation process. However, neither model examines nor illustrates how such dimensions interact and influence one another over the duration of a large scale, and lengthy, analytics adoption process.

A further input model proposed by Greller and Drachsler [14] attempts to address the dynamic nature of the dimensions that ultimately influence analytics implementations. The Greller and Drachsler model seeks to capture the interdependent yet inter-related nature of the identified dimensions mediating adoption. The model outlines 6 key dimensions or activity areas that the authors deemed as essential for the uptake of LA [14]. The dimensions included Stakeholders; Objectives; Data protected dataset; Instruments; External limitations; and Internal limitations. The dimensions were further delimited to provide a discrete set of instantiations. For example, external limitations can be related to privacy and ethics legislation. Stakeholders included instructors, students, managers or industry and accrediting bodies. While the described dimensions can be seen to further support the earlier work of Arnold et al., [2] and Bichsel [3], the model does stress the complexity of the process by articulating how the activity areas can connect in multiple and novel ways. As Greller and Drachsler [14, p.44] noted, the dimensions are "critical in the sense that each of the six fields of attention is required to have at least one instantiation present in a fully formulated LA design".

### 2.2 Output models

The output models as described by Colvin, et al., [5; 6] relate to frameworks of analytics adoption that involve a linear progression of development over time as the organizational processes for uptake mature. For example, an LA sophistication model proposed by Siemens et al. [26] outlines five stages of analytics maturity from emergent data reporting to integrated adaptive and personalized learning that influences and informs the broader sector. While the output models do provide a measure of progression over time, they lack insight and details in how organizations are able to address and overcome the obstacles and institutional limitations that will ultimately challenge the success of any LA project.

Although the input and output LA models provide valuable information for organizations to consider as they pursue adoption, they are yet to fully respond to and adequately address the breadth of complexity that shapes analytics implementations.

### 2.3 Process models

The third grouping of literature considers process models – essentially mapping a sequence of processes that are required for analytics adoption. This framing better responds to questions of how individuals get started in organizational analytics processes. For example, Ferguson, et al., [12] and Macfadyen, et al., [20] outline how the use of the RAPID Outcomes Mapping Approach (ROMA) can act as a model for informing organizational analytics. This work is an adaptation of an existing model related to policy and organizational change that has been modified for the LA context [33]. A feature of ROMA lies in the model's recognition that to enact any large scale change requires a thorough understanding of how different agents in a system behave and interact. As such, the ROMA approach begins to draw in elements of complexity theory by providing a process that can help organizations navigate and respond to the changing dynamics associated with external and internal pressures. The ROMA model recognizes the volume and diversity of actors required to respond to any calls for LA implementation. Failure to recognize the diversity of actors can result in, at best, a fragmentation of implementation; or at worst, the termination of any available analytics and reporting processes. Furthermore, process models recognize that the context, conceptualization and drivers for LA are often unique to an organization and will strongly influence the design and development of the implementation model. As such, any pre-conceived recipe for success or prescribed methodology are all too often doomed to failure. The complexity involved in such undertakings clearly demonstrates why such *ad hoc* or seemingly disjointed projects often fail or have minimal organizational impact.

Process models can be seen to draw on elements from complexity theory and transformative leadership to illuminate the alternative approaches institutions can consider. As argued by Siemens et al., [26] any approach to LA implementation must be sufficiently flexible and adaptable to rapidly respond to the concerns and problems raised by the organization's stakeholders. The capacity for an organization to respond in this manner is reliant on strong and effective leadership. Not surprisingly, and as Conklin [7] noted, there is a direct relationship between the number and diversity of actors involved in a problem and the need for high quality leadership. Though questions remain as to how the quality of such leadership is best enacted in complex settings.

## 3 COMPLEXITY LEADERSHIP THEORY

Education can be represented as a complex system [20]. Thus, LA implementations in the education context require an understanding of how change operates in such complex environments. The broad array of data sources, and the vast number of stake-

holders, alongside privacy and ethical considerations and technical integrations all push, pull and commingle within a complex system [20]. As argued above, the complexity of LA implementations demand approaches that are both flexible and adaptable. In this vein, at its core, complexity theory is concerned with change and adaptation. Complexity theory examines the interactions that occur between agents engaged and configured in complex adaptive systems [24]. Eidelson's [10] work relating complexity theory within the social sciences demonstrated that social systems operate as complex adaptive systems (CAS). Similarly, the elements and agents involved in the implementation of LA can be seen to also function as nested CAS interacting with other complex entities within a broader organizational system.

The various input and output models of LA noted above, flag the necessity for strong and high quality leadership to facilitate organizational adoption. However, contemporary education settings are dynamic and unpredictable. Therefore, new models of leadership must be considered as an emergent network of relationships that can comprise a multitude of leaders [32]. For instance, any large-scale LA implementation requires engagement of multiple managers or leaders together with the commitment from teachers to implement LA into their improvement practices. Herein lies the challenge – while effective adaptive leadership can rapidly progress LA, successful implementation is contingent on the practices of individuals operating within their discrete organizational structures or silos. Complexity Leadership Theory (CLT) investigates how leadership processes can effectively evolve through the dynamic interactions and relationships that occur between diverse actors in a system [18].

To date, much of the research on leadership in education has centred on the core attributes, qualities or skills "leaders" require to be successful. However, Marion and Uhl-Bien [21; 22] bring an alternate perspective in recognizing that leadership is complex comprising a dynamic network of relationships and interactions within a social system. Complexity leadership theory is a framework that "enables the learning, creative and adaptive capacity of complex adaptive systems (CAS) [29, p. 304]. At the same time, the framework balances these dynamic functions with the more administrative, operational and coordinating structures within the organisation (Figure 1) [29]. Figure 1 illustrates the high level conceptual interactions between the environment, enabling leadership, adaptive or entrepreneurial functions, and administrative functions within an organisation.

The importance of strong and effective leadership for analytic implementations was a consistent dimension noted in the literature [e.g.: 2; 12; 14]. Macfadyen and colleagues [19; 20] argued that the majority of senior staff leading an institution are by and large faculty members with disparate disciplinary expertise in lieu of professional managers equipped with the necessary project management related skills and expertise to guide and inform analytics adoption. Hence, senior leaders are less focused on the strategic change process and more invested into evaluations of the technology, analytics or any direct implications for workload

on associated staff. There is an imperative for senior staff to establish the necessary strategic capabilities that can effectively empower and motivate staff to make the necessary changes and decisions required for change. In this context, Colvin et al., [6] unpacked the construct of institutional “Strategic Capability” as a set of tensions operating between the various input factors that interplay on the role of leadership. Given the noted importance of leadership in institutional analytics endeavours it is surprising that this area has not been explored more deeply.

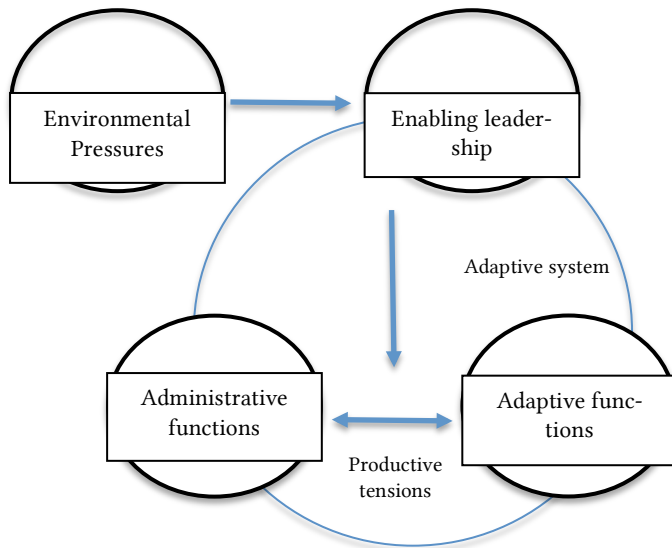


Figure 1: Complexity Leadership Theory. Modified from Uhl-Bien [28]

As depicted in Figure 1, when pressure from the surrounding environment is placed upon a system, leadership acts to enable a response by drawing on and balancing interactions that operate in two primary organizational functions – *administrative* and *adaptive*. The administrative functions are the operational and coordinating roles that allow for scale and standardisation of practices. Administrative functions can be equated to the processes and practices necessary to maintain a stable environment. That is, minimal change or disruption. In any University, the administrative functions are critical for the day-to-day operations. For example, student enrolments; lists of course offerings; and ensuring and monitoring that appropriate requirements have been met for graduation are all essential administrative functions. However, in an organization, if the locus of balance is weighted too heavily towards administration, the organisation may be slow or unable to respond to more complex pressures. In stable environments, administrative functions and control are important, and traditional individual hierarchical leadership models are effective. It should also be noted that in such a context of control and hierarchy there is a limited degree of sharing of organizational power [16]. Essentially, in stable environments, the power of control and decision-making reside with a few in-

dividuals. However, the converse can also apply. In more volatile and complex environments there is a need for greater adaptive functions that allow for distributed networks of power to emerge. In such a confluence of complex pressures, there is an imperative for more enabling leadership where power is distributed among multiple individuals in an organisation. It is the establishment of these new relationships and interactions between diverse agents that can bring about an element of organizational friction. However, such friction also results in creative outcomes and important organizational learnings [29].

The role of the enabling leadership is to effectively balance the network of interactions and organizational structures that occur within this adaptive space to best respond to the pressure. Enabling leaders have a strong capacity to forecast pressures and foster the right balance of administrative and adaptive processes, networks and relations in order to effectively respond, adapt and change in a complex environment. For example, a call for increased government accountability and reporting on education products may not necessitate a need for a novel and innovative solution. The Administrative functions of the organization may simply require further scaling. In contrast, pressures such as student retention, an aging academic workforce, implementing technological innovations, cultural and social diversity of the student cohort, or increased competition within a global market all require a more adaptive and innovative organizational response. In this context, the role of leadership is to enable a more innovative entrepreneurial response by essentially cultivating the conditions for complexity to thrive. This process leverages the organizational structures, relationships and interactions to generate a systems level response to the exerted pressure. Thus, questions remain as to how CLT can be used to understand the factors and structures working against enterprise adoption. This study identifies the elements of complexity leadership that manifest in current LA adoption processes in the Australian higher education context. In so doing, the study addresses the following research question:

- How does complexity leadership manifest in present implementations of LA in Australian universities?

### 3 METHODS

The study aimed to identify how the tenets of complexity leadership ‘play out’ in the process of LA implementations in educational institutions. The study therefore required a methodology that would allow leadership processes and decisions, and their distributed nature, to be revealed and understood within broader contextual elements (such as institutional motivations, external pressures and drivers). A socio-constructivist framing of the research construct was adopted to elicit insight into the process of leadership undertaken, and the reasons for and factors driving those leadership choices.

### 3.1 Identifying complexity leadership dimensions: Interview analysis

The study employed a mixed method analytical framework, involving four stages. Stage 1 dealt with data relating to how complexity leadership was operationalized. These data were solicited through semi-structured interviews with leaders responsible for LA implementations. Leader accounts of LA projects (including the processes they developed to afford them) were the phenomena of investigation. During the interview process leaders were requested to comment and reflect on a range of operational dimensions, including strategy, policy, governance, technology and system readiness, and staff capability, as well as broader contextual elements such as institution motivations and drivers for pursuing a LA agenda. Interviews were approximately 45 minutes in length and transcribed verbatim.

Stage 2 involved the analysis of the qualitative interviews using a thematic approach. Braun and Clark's [4] Thematic Content Analysis was adopted to scrutinise accounts, and reveal salient ideas, representations, or meanings within the texts. This involved a series of phases. The first phase relates to the reviewing of all text and capturing occurrences of any idea or expression in the text that reflected LA or any process affording or militating against LA activity. This process was inductive, and resulted in 1485 text segments being assigned to 56 'ideas' or 'tags'. For this purpose, a 'tag' refers to a basic element or segment in the data. In the second phase, tag categories were reviewed and grouped to form potential themes, or "patterned response or meaning" within the data [4]. This was an iterative process and care was taken to ensure that the identified themes were internally consistent, while externally distinct. At the conclusion of this process, there were 19, inductively-generated potential themes.

In Stage 3, themes, and the text within them, were reviewed deductively against noted dimensions of complexity leadership theory [18; 22]. The final grouping of themes included: development of "staff operational capacity"; building of "staff culture"; assignment of "leadership" roles and processes; establishment of operational or steering "committees"; establishment of an institutional LA "strategy"; practices to promote and engage stakeholders through "consultative planning"; defining LA as an activity associated with teaching and learning practice; and establishment of "governance" bodies for ongoing oversight. It is important to note that within each theme there was a range of operationalizations. For instance, within the theme "strategy" there was a divergence of processes identified. Some institutions placed importance on developing strategy as an antecedent to LA activity; other institutions had a more temporally relaxed approach to strategy development, with strategy developed alongside LA implementation. Diverging operationalizations were identified within each of the themes, and these operationalizations were classified as representing an orthodoxy, or representing an emergent practice or process.

The level of maturity of implementations across the various institutions greatly varied. In some cases, projects had been underway for several years; in other instances, the projects were embryonic. Those institutions in the very early phases of LA adoption offered very little insight around the complexity leadership dimensions and were mostly coded as '1' across the identified dimensions. In these cases, the institutions were removed from the dataset. Therefore, final analysis was conducted on the responses from 26 Australian tertiary institutions. This represents 67% of all Australian public universities.

Stage 4 included the analysis of data to reveal the patterns and relationships associated with complexity leadership evolving from the LA implementations. The latent class analysis is outlined further in section 3.3.

### 3.2 Research site

The research site included all universities in the Australian higher education landscape. Data were collected as part of a larger national research project [see: 6]. In total, 39 higher education institutions in Australia were invited to participate in the study with 32 institutions agreeing to participate, representing 82% of Australian universities. As noted above the preliminary coding resulted in a final sample size of 26 universities. Ethics approval for the study was granted by the institutional ethics committee.

### 3.3 Latent class analysis

To enable interpretation of patterns within this rich and diverse summary of practices around LA implementation, latent class analysis (LCA) [23] was conducted using categorical data representing dimensions of information flow and power structures. The dimensions used for LCA analysis included:

- *Committees.* This category related to whether the leaders appeared to organize LA activity through existing committees (2), or if the committees were newly created/ informal working parties were a part of the process (3), or not reported (1).
- *Consultation.* In some instances, leaders reported that LA planning was undertaken through consultative processes (3) or written by a (group of) senior leader with no evidence of consultation with staff (2), or not reported (1).
- *Governance.* This category related to the oversight, reporting lines and accountabilities. In some instances, these were noted as formal and existing (2), in other, leaders talked about the new processes in place (3), or not reported (1)
- *Leadership.* Most leaders talked about how they wanted LA to be structured. In some institutions, this was deliberately controlled by senior management. In other cases, institutional leadership was devolved, relying on bottom up structures. Therefore, the three categories of this dimension were top-down (2), bottom-up (3), and not reported (1).
- *Strategic Planning.* Through interviews it was observed that institutions were either strategy-driven, or activity-driven where practice was understood as the interpretation of the

strategy. If strategy was interpreted through practice, iterative, this category was coded as iterative strategy (3), or preceding strategy (2), as well as not reported (1).

Latent class analysis [23] was applied to these categorical variables to understand if there was a latent structure defining different classes of institutional practices. LCA has been commonly applied to derive typologies based on dichotomous and categorical variables [30]. The approach conceptually differs from cluster analysis, in that it assumes that the manifest variables (i.e. complexity leadership dimensions) are related based on the underlying latent classes of institutions (i.e. is model-based). Modelling starts with one class, where the next iteration models  $k+1$  classes. We have implemented ten iterative models to the dataset, with 2 class-solution being most meaningful based on BIC, AIC, and entropy scores; as well, the small size of the dataset and the diverse responses on our five selected dimensions resulted in the negative degrees of freedom for most of the model.

### 3.4 Limitations

While the study presents a representative cross-section of the Australian higher education sector there are limitations to the work that impact on the generalizability of the findings. For instance, the work is derived from analysis of staff interviews. The self-report nature of the interview process lends itself to a set of imperfections due to the inaccuracies of recall and perception. Future studies should bring in more robust approaches that also seek to examine the artefacts of adoption and a broader sampling of key stakeholders. The analysed data were not directly collected in alignment with CLT approaches. Instead a framing of CLT was applied to the findings. As such the analyses only surface productive tensions that evolve in LA instantiations. Future work could further unpack these sites of productive tensions and the nature of the dynamic networks that comprise these settings. CLT effectively examines the dynamic nature of the organizational networks. Hence, the inclusion of SNA would also add to the rigor of future studies and enable a more comprehensive assessment of leadership models promoting organizational adoption of LA.

## 4 RESULTS

### 4.1 LA leadership approaches

LCA resulted in a two-class solution describing the types of leadership driving the practices around LA implementation. LCA models membership in a class as a probability of belonging, i.e. if a case belongs to a class, its probability to belong to another class decreases. Table 1 reports on the identified classes, referred to as 'Class 1' and 'Class 2'. The results demonstrate there was a 61% probability for institutions in Class 2 to employ a bottom-up leadership structure. Class 2 also demonstrated 88% probability that institutions would be putting in place new committees, 62%

probability that they would apply an iterative strategy, and 89% probability that their planning processes have been consultative. Class 2 contained 11 institutions. In contrast, for Class 1, we observed a high probability of not reported implementation practices, and a comparatively higher probability of practices describing formal structures. Institutions in this class were more likely to employ top-down leadership, existing committees, preceding strategy, not consultative, and apply formal existing mechanisms for reporting and accountability.

Table 1. Classes of LA leadership

Dimensions	Class 1	Class 2
<i>Leadership</i>	14%	61%
Bottom-up (3)	54%	0.09%
Top-down (2)	32%	28%
Not reported (1)		
<i>Committees</i>	0%	88%
New (3)	47%	0%
Existing (2)	53%	12%
Not reported (1)		
<i>Strategy</i>	13%	62%
Iterative (3)	33%	27%
Preceding (2)	53%	10%
Not reported (1)		
<i>Consultation</i>	20%	89%
Consultative (3)	40%	0%
Not consultative (2)	40%	10%
Not reported (1)		
<i>Governance</i>	20%	36%
Newly created (3)	20%	18%
Formal/existing (2)	60%	46%
Not reported (1)		

To gain insights into other dimensions describing these contrasting leadership types, Table 2 presents the frequency counts of other dimensions of complexity leadership in relation to the LA implementation. Notable differences observed include institutions in Class 1 under *Staff Capability* reported opportunities for training staff to control LA, while this was not reported in Class 2. There was a much higher number of institutions that did not report anything under Staff Culture in Class 1 compared to Class 2. There was a considerably higher number of institutions in

Class 1 than in Class 2 reporting on activity related to “not teaching and learning” under the *Activity Breadth* category.

**Table 2. Frequency of complexity leadership dimensions**

Dimension	Description	Class 1 (n=15)	Class 2 (n=11)
Staff Capability	Not reported	6	5
	Institutions training staff to control LA	2	0
	Equipping staff with resources	7	6
Staff Culture	Not reported	8	3
	Sharing and encouraging conversations around LA	7	8
Evaluation	Not reported	8	7
	LA used to evaluate	4	3
	Evaluating to improve LA	3	1
Activity Breadth	Not reported	4	5
	Activity not teaching and learning	9	3
	Activity as teaching and learning	2	3
Driver	Retention	5	4
	Learning	4	2
	Efficiency in administrative decisions	6	5

## 5 DISCUSSION

The enterprise uptake of LA in education is an ongoing challenge [20]. As LA research continues to grow there is a very real danger of a widening gulf between identified research needs and outcomes and applied practice [9]. LA, is by and large, an applied research field [8]. As the gulf between research and practice extends so too do the barriers to adoption. Clearly, there is a need to explore why LA as process for providing data and information (e.g. reports and dashboards) to educators and students are not more readily available. This study aimed to examine how the concept of complexity leadership theory (CLT) can provide new insights and thinking about how analytics adoption processes unfold in education settings. To achieve this aim, the study undertook an analysis of 26 interviews with senior administrators in Australian public higher education institutions. The interviews were qualitatively coded to identify the emergence of noted dimensions of complexity leadership in organizational adoption of LA. In so doing, the study examined how complexity leadership manifests in present instantiations of LA in Australian universities.

To frame the discussion and interpretation of the findings we first briefly unpack the process of CLT in organizational settings. Marion and Uhl-Bien [22] maintain that CLT occurs both on a

micro and macro organizational level. Essentially, at the micro level complexity leadership seeks to identify and cultivate the processes of association among independent units to form aggregations around shared outcomes and goals. For example, drawing on figure 1, this may comprise establishing an alliance between the adaptive and administrative functions of the organization or building a ground swell of alliances among the adaptive units. At the macro level complexity leadership relates to the structures and behaviors within the organization that arise from and among the operational practices of the various discrete sub-units. It is important to note that leadership at the macro level is not about directing behavior. It is about identifying and cultivating sites of influence, formal and informal that are effectively managed through networks of relationships [32]. CLT recognizes that contemporary leadership is not an attribute of a single individual but a recognition that leadership is an emergent social process [18].

### 5.1 Interpretation of the Results

The results of the present study identified two classes of organizations in relation to the observed dimensions of complexity leadership. The two classes differed in their analytics approach and conceptualization - from an instrumental approach (Class 1 – top down models of LA implementations) to emergent innovators (Class 2 – bottom up).

Class 1 was interpreted as adopting an “Instrumental approach”. The key feature of this class was the implementation of a top-down leadership model. The institutions comprising this class had a shared and pre-established symbolic cause for implementation and resourcing. LA was conceptualized as a means to address the challenges associated with student retention. While the common rationale for implementation results in rapid access to and leveraging of the structural power that resides within the organizational hierarchy, there was limited exposure to how LA could better address the immediate concerns of key stakeholders. Simply put, the tools were available but there remained limited understanding how such tools can be used to improve student retention. The focus on top-down leadership for implementation resulted in limited resources assigned to building staff awareness and a shared understanding of how such analytic practices can be used to resolve organisational issues. In essence, the institutions were devoid of staff capacity building options and promoting opportunities for staff to engage in innovation and exploration of how such tools are best utilised in the context of the institution.

In Class 1, while the majority of examples cited were large in scale they were yet to demonstrate any significant uptake or impact among teaching staff and students. This may lie in part due to the nature of the management associated with the LA project. All too frequently, LA is conceptualized as a technical solution to an education problem. As such oversight and management of LA is assigned to core administrative units (e.g. IT units) establish the various rules and regulations guiding access to data and adoption of technologies. In this context, the remaining stake-



holders of the organization are perceived as a “client” in lieu of a key contributing stakeholder or potential leader. However, a key aspect of effective leadership in an organization is influence. And influence is not necessarily hierarchical in nature but is often emergent and apparent through informal as well as formal mechanisms. Although the assignment of LA to an administrative or operational group can serve to ensure progress is made in terms of establishing the necessary infrastructure and processes, attention to identifying key staff of influence to promote uptake and awareness is also essential.

For Class 1, the macro-level leadership effectively functioned to embed the infrastructure for uptake. However, further steps are required to seed cross-structure network relationships. This may entail wider stakeholder engagement and seeding opportunities for research and innovation around the specific sites of productive tension. As well noted by Arena and Uhl-Bien [1 p.23], linkages between disparate units are often “hard to make because organizational bureaucracy and silos can create obstacles to interconnectivity”. Leadership within the Class 1 institutions must focus further on establishing practice that can help staff transcend these operational barriers to seed and promote inter-unit collaborations. At the micro level, leaders can act to promote and identify those key leaders of influence that reside in the multitude of sub-units in a university. In so doing, leaders are actively unpacking the root cause of productive tensions that are impeding uptake. For example, a specific area of tension may relate to increasing academic workload. The identification of students at risk of academic failure or attrition also contributes additional workload to teaching staff through increased email and student support. The presentation of at risk indicators can place the onus of burn onto teaching staff. This can be effectively managed through additional administrative support or developing alternate processes to aid the scalability of support practices. For this class of universities, senior leaders can work to establish a forum to raise these tensions and to bridge new network linkages to aid the development of novel solutions.

Class 2 is referred to as the “emergent innovators”. The traditional hierarchical – or top-down models of leadership are not applied in this example in order to cultivate adoption. This class is more associated with the developing alliances among independent units. This approach is more commonly referred to as a bottom-up model of adoption. The adopted approach is reflected in the observation that this class of senior administrators tended to holistically conceptualize LA as process for informing the continuous improvement of student learning practice in lieu of an identified response to an institutional issue. The leadership was more focused towards practices that aimed to build staff awareness and capacity regarding the use of analytics for improving and measuring learning and teaching. As such, there were a multitude of exemplars and exploratory LA projects in train across this class of organizations. In most cases, the administrators could identify specific examples of excellence across their institution. However, there was a dearth of ideas and strategy that could serve to promote opportunities that can lead to scaling an-

alytics practices across the organization. Essentially, the approach undertaken by this class of universities can be characterized as divergent and un-directed. Thus, complexity leadership at the micro level needs to continue to foster the aggregation or alliances that will evolve as a common cause or problem is identified. The macro-level leadership should focus on further re-sourcing collaborations to foster the development of stronger network relationships among the independent sub-units. At the same time, leaders will need to be aware of and rapidly respond to the dynamics and tensions that can arise between the growing ensemble of adaptive units seeking administrative support or change. A lack of attention to address or mediate the policy limitations, and socio-technical tensions that emerge in these instances will lead to a disenfranchised group of key stakeholders and practitioners.

In summary, to progress the adoption of LA among the emergent innovators, leaders of institutions similar to those identified in Class 2, must identify and spark a common cause that can stimulate and draw on the hidden structural power that lies within the organization to extend uptake. Holland [17] refers to these emergent bottom-up goals as symbolic “tags”. A leadership tag, for instance, can act as a symbolic catalyst that serves to unite groups and promote organizational change around a common cause. Complexity leadership requires the identification of multiple symbolic leaders, events or issues that can unify disparate groups to promulgate change in practice.

## 5.2 Implications for Research

The findings from this study raise several important areas for LA research. The research undertaken in LA is commonly built off individual cohorts or classes. The scale of the studies undertaken in MOOCs or via industry (LMS providers and publishers) has been an exception. However, for schools and universities much of the work has stemmed from individual classes or programs. A plausible reason for this situation is the ease of access to data and the experimental conditions for the researcher.

There is a need to broaden our focus of research in LA. 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. Figure 1 pushes the organization into a simplistic binary of operational/administrative units and those with a more adaptive focus. Clearly, a binary approach is not practical for contemporary knowledge based organizations. It is the space of interaction that occurs between these units where the productive tensions lie. Further research is required to understand how LA can shape and influence this domain. Sites of productive tension or friction generate the most novel and creative responses.

Effective leadership in education settings is about recognizing the importance of informal power structures and understanding the interactions and complex dynamics that operate in this space. Leaders working in the context of complexity must shape the information flows and relationships that are best harnessed

to effect change. Through this more dynamic and responsive leadership approach LA can begin to realize its potential in supporting change in education to more active and adaptive learning.

## 6 CONCLUSIONS

The analysis of the interviews with Senior University leaders demonstrates that while LA adoption processes in Australia are embryonic they are progressing. The results suggest that the 2 primary processes for adoption. For example a top-down leadership approach whereby, the implementation of the technical infrastructure is prioritized over staff capacity building and smaller scale learning centric projects. In such instances, there are noted reports that uptake among teaching staff is often sporadic and met with resistance. Conversely, institutions employed a process of seeding a myriad of innovations and small scale projects. This approach does little to act as a catalyst for change. The study highlights the need for complexity leadership as a model to explain and navigate the dynamic formal and informal power structures present in education organizations.

Universities are bureaucratic organizations. That is, they operate within and are defined by established rules and regulations and functional assignments (administrative support, IT, disciplines of research and teaching such as STEM, social sciences). This process of operation creates perceived barriers or silos among the sub-units. In stable environments such organizations are effective and leadership can be hierarchical. However, change in education is a constant and such operational models are increasingly ineffective in responding to the speed of change required for contemporary knowledge based organizations [15]. When working in complex adaptive systems such as education, there is a need for shared and transformational leadership. Linear cause and effect models are ineffectual and only serve to maintain the status quo. Complexity leadership presents a model for LA adoption that can deal with the dynamic and unpredictable nature associated with 21<sup>st</sup> century education.

## ACKNOWLEDGMENTS

The authors would like to acknowledge the expertise and commitment of the many individuals that so generously provided their insights and reflections on this research. Support for the production of this paper has been provided by the Australian Government Office for Learning and Teaching. The views expressed in this paper do not necessarily reflect the views of the Australian Government Office for Learning and Teaching.

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