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Article

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The challenges of teaching complexity sciences to novice learners in public administration

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Abstract

There is a rich history of examining the functions and activities of public administration through the lens of complexity theory. Arguments for training and educating public administrators in this discipline are both longstanding and highly relevant in the modern-day context. This paper seeks to add to the existing literature which explores educational methods for teaching complexity sciences to public administrators through a novel analysis that integrates two different psychological domains - applied cognitive psychology and adult developmental psychology. Introducing the notion of thought architecture, this analysis will first acknowledge that public administrators are likely novices in complexity, due to their limited exposure to necessary declarative and conceptual knowledge and their stage of adult development. Second, this analysis will show that features of a complex system exist in tension with instructional methods typically associated with helping novices acquire knowledge or advance in their stage of adult development. In light of this finding, appropriate and useful instructional strategies drawn from these two psychological domains that help to reconcile this tension will be discussed.

Keywords

Psychology, complexity science, complexity theory, adult development, cognitive science, learning, professional development

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Introduction

This article explores the challenges faced by educators when they seek to develop how public administrators comprehend and response to complexity. First, there is a rationale for why complexity theory is a foundational construct for public administrators (PA) to learn, in reference to the rich history and knowledge which has explored complexity within the domain of public administration. This paper subsequently examines the demands which educators and educators face when designing learning experience for those working in the field of public administration. Specifically, using the lenses of adult developmental psychology and applied cognitive psychology, several unique challenges facing the educator are raised and practical implications for the practice of educators are discussed.

Why should public administrators learn about complexity?

Complexity theory defines the operational environment in which a PA will need to make decisions. Public administration, and therefore PAs, are concerned with the work required to enact and manage government policies and programmes on behalf of its citizens (Dooley, 1997; Franklin and Raadschelders, 2023; Raadschelders, 2011). The interconnection, non-linearity, and emergent properties associated with complexity theory provide a useful heuristic for understanding policy making (Cairney, 2012), which subsequently influences the activities and direction of a PA. French et al. (2023) have recognised the relevance of complexity theory for conceptualising outcomes in public administration – a key concept given the pressure placed on public sector organisations to achieve reliable results for the citizen. In addition to these macro-level considerations, complexity is also relevant for shaping the day-to-day experience of a PA. For example, Geyer and Harrison (2021) noted the relevance of complex systems for governance. Hawkins (2023) recognised how the properties inherent to performance management can be profoundly affected by the complex nature of a system. In summary, there are many ways in which complexity theory defines the operational environment of those working in public administration.

One of the ways in which this complex operational environment is relevant is the direct effect it will have on PA decision making. Within interconnected, emergent and open systems, PAs are likely to face great ambiguity (Boulton, 2024). This will instigate a process of comprehending the situation and how they should act – a process referred to within the psychological literature as sense-making (Holt and Cornelissen, 2014). How individuals undertake this sense-making will fundamentally affect how a person comes to a decision and, therefore, the subsequent impact they might have (Weick, 1995; Gilbride et al., 2021). It is for this reason that many in leadership, a domain focused on the social process of influence (Northouse, 2016) have called upon the need to increase leaders understanding of the complexity sciences (Boulton et al., 2015; Varney, 2021). Hence, there is a rationale that PAs could benefit from comprehending the complexity of their environments so that they are best prepared to make decisions in accordance to the

complexity which drives their working environments. (Hawkins and James, 2018; Stacey, 2000).

Complexity theory is more relevant to the work of PA than ever before. The internet and tools such as social media platforms have broadened professional networks, provided greater access to information for PAs, and increased the speed at which they encounter new information (Child and McGrath, 2001; Uhl-Bien et al., 2007). The growing adoption of distributed management models (Jakobsen et al., 2023) has resulted in individuals being exposed to the complexities of decision-making processes that would have previously fallen outside their scope of responsibility (Hartley, 2007; Morrison, 2010). Preferences for more comprehensive management styles (Boyatzis et al., 2013) and the roles that leaders may be expected to play in areas such as social justice, diversity, mental health, and inclusion (Mullin et al., 2021) have expanded the scope of individual and group interactions to encompass broader social and organizational goals. These changes can be said to increase the exposure of PA to interaction, emergence and the interconnection - all core features of complex human systems (Lewin, 2000; Varney, 2021).

The importance of teaching complexity concepts to learners has been acknowledged within the field of complexity sciences (e.g., Byrne, 2014; Cairney and Geyer, 2017) as well as in the professional development of public administrators (PAs) (e.g., Rhodes and Eppel, 2018). Specific tools such as vignettes and case studies (Straussman, 2018), as well as learning communities (Wilson et al., 2023), have been identified as beneficial for helping PAs understand and manage complexity in their work. This special issue aims to explore how we can further advance the education of PAs by supporting their recognition and application of complexity in their professional practices. This paper aims to contribute to the existing knowledge by providing a psychological analysis of the key characteristics of complexity theory and identifying new challenges that teaching complexity poses to both learners and educators in public administration. By integrating two distinct psychological fields—applied cognitive psychology and adult developmental psychology—it seeks to offer a broader understanding of public administration learners and a wider range of instructional methods than using a single domain alone.

Our role as educators should be to help individuals think through the complexity of their environment. That is to say that their underlying structure of thought anticipates their environment as complex (e.g. dynamic, adaptive, emergent, interconnected etc.) as opposed to thinking about their contexts as linear and reductionist. The metaphor introduced in this article to describe this underpinning structure of thought that subsequently shapes and provides a framework for understanding our environment will be ‘thought architecture’. This metaphor is unique in stressing how an individual’s approach to thinking will require two key components:

- Acquiring knowledge on complexity theories and systems.
- Conceptualising and making sense of this knowledge in such a way that helps them to comprehend the complexity inherent to the context around them.

Applied cognitive psychology enhances our understanding of how individuals acquire and retain knowledge, which is essential to our cognitive processes (Willingham, 2017). The term 'applied cognitive psychology' in this article will be used as a term to define the use of theories and ideas from cognitive science that is being brought into the field of education and learning (Willingham, 2017; Rittle-Johnson et al., 2020). On the other hand, adult developmental psychology is the domain which primarily explores how adults organise their knowledge to make sense of the complexity of themselves and their environment. Adult developmental psychology has sought to analyse the experience of adulthood and how we develop through the later stages of our lives (Kegan, 1982; Loevinger, 1976) and there's an array of different theorists within this domain. In this article, Jane Loevinger's' theory of adult ego development (AED) is used in this article to define the developmental trajectory by which adults develop the capacity for comprehend complexity across the adult lifespan (Hy and Loevinger, 1996; Loevinger, 1976). I have selected this theory as it is a robust theory of how adults develop over the lifespan (Manners, Durkin and 2004; Lanning et al., 2018), and how the content of each stage directly explores capacity for comprehending complexity (Gilbride et al., 2021; Gilbride et al., 2023).

These domains have been brought together for two reasons. One, that each individual and unique contributions of each domain add substantive value to understanding the learning experience in a way that the other domain cannot on its own. Second, as a form of triangulation. There is power in how two domains with different underlying philosophies, nomenclature, methodologies, and dominant theorists can derive the same conclusion. This conclusion being that, as a body of knowledge, complexity theory has unique considerations that will be challenging for the learner to comprehend and transfer into their own practice.

This analysis will be driven through the following three questions:

- The readiness of individuals to undertake learning.
- What barriers do PA professionals face when they are expected to acquire and retain knowledge on complex systems.
- What can be done to support PA professionals.

The readiness of the learner - why are public administrators likely to be 'complexity novices'

Understanding the starting point of the learner is a foundational requirement of any educator in any field. It is recognised that those with substantive background knowledge within the domain to be learnt respond to problems and stimuli in fundamentally different ways compared to novices (Auerbach et al., 2018; Rosenshine, 1995). Kirschner et al., (2006) recognise that those who are new to a discipline will require a fundamentally different approach to that of those with prior experience and acquired expertise. This section will articulate that the likely starting point for many PAs embarking on a piece of professional development are novices in relation to complexity. In other words, Pas are likely to be 'complexity novices'.

There are two reasons why it reasonable to assert that many PAs will be 'complexity novices'. The first reason is that, within their thought architecture, they are unlikely to hold deep conceptual knowledge on complexity. In applied cognitive psychology, a novice is considered to have little to no prior experience or knowledge within a specific domain, whereas experts have both a greater breadth of knowledge and a more developed schema within a specific domain (Persky and Robinson, 2017). Individuals are therefore considered a novice when it is deemed unlikely that the individual will hold one of the pre-requisites of expertise – the domain specific declarative and conceptual knowledge of the concept (Zambrano et al., 2019). It is unlikely that adult learners will have spent extensive time studying features of complexity sciences within any mandatory study programmes. Complexity theory is not mandated topic on graduate curriculum or leadership programmes within the public and private sector (Hood and Jackson, 2019; Stoten, 2021) and calls for complexity to place a more prominent role in PA curriculum remain (Bottom et al., 2022). Indeed, many systems of management appear to reinforce the opposite to complexity, giving very little change for individuals to learn this knowledge through an experiential approach either (Varney, 2021). As such, in relation to the knowledge a PA is likely to hold, many PA professionals are likely to be a complexity novice.

The second reason is that PAs are unlikely to be at a stage of adult development whereby they can recognise complexity in their environment. Jane Loevinger's' theory of adult ego development (AED: Loevinger, 1976; Hy and Loevinger, 1996) described how sense making system can change over the life span. It's only as adults progress to later stage of development where features of organisational complexity are truly recognised. These include the challenge of establishing direct causality recognising relative unpredictability, the relative ambiguity of a complex system and inter-connectivity between parts of a system (Gilbride et al., 2023; McCauley et al., 2006; Pfaffenberger and Marko, 2011; Vincent et al., 2015).

The typical distribution of AED stages in the population will therefore be an important factor in the readiness of adults in their sense-making capacity. However, only circa 6% of adults occupy the later stages of adult development associated with greater recognition of complexity (Cook-Greuter, 2004; Lanning et al., 2018). Therefore, according to stages of AED, it is unlikely that any group of adult learners will recognise and tolerate complexity from their experiences without considerable scaffold or support. As such, even if they are presented with complex circumstances, it is unlikely that their thought architecture will be sufficiently developed enough recognise or perceive the features of complexity that are inherent to that environment independent of instructional scaffold and support.

So far, I have argued that many learners are likely to be a 'complexity novice' This could be because their unpinning thought architecture is likely to hold the declarative and conceptual knowledge associated with complexity, that they are likely to be at an earlier stage of AED of development, or both. The next section of this article will discuss how learning within the domain of the complexity sciences affords unique challenges to the educator seeking to develop the novices' knowledge and awareness of complexity

Complexity sciences offer unique challenges to the education of the novices

So far, the argument has been as follows. Different psychological domains recognise that it is likely for many PAs to be complexity novices because of their knowledge and AED stage development and that the status of novice is important when designing learning experiences. In this section, attention will be turned to the unique challenges which an educator will face in teaching novices in the domain of complexity.

Developing the knowledge of the novice

In the domain of applied cognitive science, a central way to support novice learners is ensuring the acquisition of declarative and conceptual knowledge within a given domain. This domain recognises it is that the knowledge stored and retained by the learner that shapes our capacity to think and conceptualise ideas (Rumelhart and Ortony, 1977). Hence, the acquisition, comprehension and application of knowledge is a substantive part of the alteration that "takes them (learners) beyond their own experiences" (Young et al., 2014: 7). In this sense, knowledge is critical to developing the thought architecture of the novice. If we do not hold the declarative and conceptual knowledge of complexity which is readily accessible, we cannot expect an individual to start to conceptualise or recognise the stimuli around them as part of a more complex whole.

Direct instruction is recognised to benefit novice learners in the acquisition of new knowledge. According to one proponents of this method, (e.g. Rosenshine, 1986) instruction should start with teacher led modelling and exposition. Over the course of instruction, instruction is faded from teacher-led to learner led, initially via approaches such as 'shared modelling' where the teacher and learner work side-by side, (Stockard et al., 2018). The purpose is to get to a point where the learner can apply the learning independently with a higher chance of success (Pearson and Gallagher, 1983). In addition to this gradual transition from teacher to learner, extraneous information should be removed as much as possible, and examples should be used to provide a simplified and concrete reference to the ideas discussed (Paas et al., 2003). The gradual movement from teacher to learner led instruction, chunking, content control and exemplification help manage cognitive load – a theory of information processing which shows how we can minimise the load of instruction, or extrinsic load, for novices by taking these steps (Sweller, 1988).

However, the needs of the novice can present a challenge to the complexity science educator. Many of the features inherent to complex systems can be contradictory to what novices typically need from instruction to comprehend, acquire and retain knowledge. This can be said to occur in two ways:

Broken down. Novices are more likely to learn when a concept is broken down into smaller 'chunks' of information (Thalmann et al., 2019), The demand to break down a concept into smaller parts may contradict one of the key concepts within complexity theory. That is, complexity theory describe systems which are broadly recognised to be

more than the sum of their parts, highly interconnected and nested within other systems (Stacey, 2000). Herein lies the contradiction – how does one present a system which is broken down into smaller parts, whilst also demonstrating the interconnectivity that is present within complex systems? Striking this balance is the difference between teaching a misconception about complex systems (they can be broken into smaller parts) and overloading novice learners.

Concrete examples. Concrete examples can be defined as tangible and contained examples which are familiar to the learner (Mayer, 2005). Novices benefit from multiple concrete examples to help them develop an understanding of the knowledge and to transfer their knowledge to different contexts (Chi et al., 1981; Rawson et al., 2015). However, this need for concrete examples contradicts the notion of complexity. Complex systems are described as emergent and difficult to capture in a static description (Holland, 1992; 2006). As such, offering concrete examples in of itself might create a misconception about complex systems. However, not providing them might overwhelm the novice and prevent learning.

Therefore, due the features inherent within complexity theory, the key tools used by the educator to support the novice to acquire the necessary knowledge becomes challenging to utilise.

Advancing the capacity of the novice to make sense of complexity

Another part of the thought architecture is the approach by which the individual uses and applies their knowledge. Through the lens of adult developmental psychology, this has been defined in this article as their stage of adult development. The learner is likely to be a 'novice' in that there is a high chance there are earlier stages of development where complexity recognition is limited. Therefore, the features of complexity can be said to demand that educators consider how they promote late-stage development in their learners.

There are several challenges that educators have in this regard. First, it can be implied from the rarity in which actors occupy later stages that that moving through stages organically is challenging. Part of the reason stage development is hard to achieves to overcome one of the central purposes of our psyche - to provide consistency in situations which otherwise would be intangible, and we would have no explanation for (Hy and Loevinger, 1996; Loevinger, 1976). Therefore, the educator needs to overcome the paradox of developing an individual for whom much of their internal systems purpose is to provide stability.

Second, some of the techniques which are used for AED stage development appear to only demonstrate consistent efficacy at the earlier AED development. For example, studies which have promoted stage development in formal leadership and professional development programmes notice a drop off in success at the later stages of development necessary for complexity recognition (King et al., 2000; Manners et al., 2004; Vincent et al., 2013). As such, traditional tools appear to not have as greater efficacy for the stage development required.

A specific example of such a technique is a disruptive experience. Disruptive experiences are when individuals are exposed to situations, contexts or situations which cause conflict and expose how their underlying sense-making system is incomplete or insufficient (Manners et al., 2004). Disruptive experiences can force individuals to reconsider their underlying approach and open up the potential for new knowledge and observation to take root (Kegan and Lahey, 2009). The consequence could be to support the development of individuals in later stages of adult ego development (Manners and Durkin, 2000) which more closely align to the features of complexity. Individual studies have observed that AED development, and subsequently a greater capacity in comprehending complexity, across a range of different potentially disequilibrating experiences: higher education (Loevinger, 1976); life experiences such as divorce; (e.g. Helson and Roberts, 1994) and programmes of intentional development (e.g. Baron and Cayer, 2011). However, progress for individuals across these studies has been mixed – not all individuals respond to the intervention for those transiting to the key stage – the individualist stage, and beyond was less common in these interventions (King et al., 2000; Manners et al., 2004; Vincent et al., 2013).

Finally, educators must recognise that inducing AED development can have short-term detrimental consequences upon the learner's emotional stability. For example, disruptive experiences involve placing individuals in unclear circumstances and are exposed to ambiguity and challenge (Drago-Severson, 2012; Manners and Durkin, 2000). Intentionally increasing exposure to complexity can cause compromise the socio-emotional well-being of an individual (Van Velsor and Drath, 2004). Therefore, just as counsellors need to exercise caution in their application of ideas to practice, so do educators when developing individuals' ideas around complexity.

The challenge for the educator in supporting the novice is therefore as follows. Individuals are likely to be complexity novices due to their lack of exposure to knowledge and underdeveloped stage of adult ego development. Critically, whether that is through the applied cognitive sciences which proposes methods such as direct instruction, or adult developmental psychology with tools such as disruptive experiences, the inherent features of a complex system compromise the tools typically applied to novices. The next section will discuss what acts of intention design that educators can take to help novices overcome the challenges of learning about complexity.

Discussion

In this paper, I have used two different psychological domains to shed light onto what challenges educators are likely to face in developing the learners' 'thought architecture' in relation to complexity. Indeed, someone of these challenges involves them reconciling the paradox between the features of complexity and the sorts of teaching approaches which are known to be particularly effective for novices. Others is recognising that the advanced progression required places negative pressure on teaching approaches worked for earlier stages of development. The question to now turn to is how can educators design with these challenges and paradoxes in mind?

Recognising these paradoxes and challenges in of itself can help the educator direct their attention in how they adjust the design of their sessions. For example, case study methods are commonly used across many programmes as a way of providing a concrete and detailed example of given phenomena (Krain, 2016). The question, considering the argument above, should be how the educator designs case studies which balance the novices' need for concrete, broken down instruction without creating the misconception of a complex system?

One way the design of these cases to gradually could be to increase the exposure to specific features complexity over the course of a series of case studies, linking each exposure to the incremental development of knowledge. Gradually revealing the complexity inherent could help minimise cognitive load, enable a broken-down approach complexity whilst remaining 'true' to the nature of a complex system over time. Such an approach has been applied to other approaches which have taken a psychology-informed model of complexity development, such as Getting Heads Together (Getting Heads Together, 2021).

There is the challenge of supporting a learner to analyse and comprehend a concept which is likely to be outside of the learners' stage of AED. As such, without a scaffold to support how novices think and identify complexity, even broken-down case studies could be rendered ineffective.

Applying a metacognitive scaffold here could overcome challenges presented by earlier stages of AED. A scaffold can be defined as an instructional instrument, tool or device which is utilised by educators to support a learner in achieving an outcome which might otherwise not be possible for them to complete on their own (Rosenshine and Meister, 1992; Van de Pol, Volman and Beishuizen, 2010). Metacognition can be loosely defined as thinking about thinking (Flavell, 1979). Approaches which therefore embrace metacognition will structure the way in which a learner can think through the case study, enabling the learner to expose ideas that they might not otherwise on their own (Vukman, 2005).

There are several ways in which a metacognitive scaffold could be employed. Such an approach might be directly through the teaching modelling the process for deconstructing or analysing the case study, actively showing where and how a system is complex (Shulman, 1987; Rosenshine, 1995). Tools such as the ladder of inference (Argyris, 1982; Senge, 1990) facilitate the process of individuals deconstructing an example and their own inherent potential biases through to recognising the ambiguity, different forms of evidence and wider range of perspectives. Finally, reflective cycles such as Gibbs (1988) and Kolb (Kolb and Kolb, 2018) could enable individuals to deconstruct their own experience and scaffold new meaning, especially when paired with targeted questioning.

Finally, the educator might need to recognise the learners' emotions in designing complexity informed instruction. The learning process has long since been recognised to be trying and the socio-emotional conditions of learning have been demonstrated to impact on a range of learning outcomes (Kwon et al., 2020). This is particularly pertinent to learning within the complexity sciences, where the learner is likely to be a novice and find the concept of complexity challenging to adopt. The consequence could be that asking learners to embrace complexity will require learners to feel psychologically safe to

be wrong, admit to vulnerabilities and weaknesses and be prepared to collaborate meaningfully.

Psychological safety "describes perceptions of the consequences of taking interpersonal risks in a particular context such as a workplace" (Edmondson and Lei, 2014: p.24). If an individual does not experience psychological safety, these three features can be undermined, and their capacity o transfer their learning into different environments could be compromised. Although the necessity of complexity to the PA has been made clear in this article, the educator might wish to consider whether the learner is ready to be challenged in the manner required and that they have made the risk clear to the learner. Furthermore, they should encourage the learner to reflect on whether the conditions of psychological safety are sufficiently established prior to commencing their programme of learning. the necessary conditions are in place for the learner to engage in their professional learning.

Conclusion

The paper has re-articulated the relevance of complexity to the PA. The novel integration of two psychological lenses within this paper – applied cognitive and adult developmental psychology, has exposed how complexity theories can places unique demands upon the development of a learner's thought architecture in relation to complexity. Furthermore, it is the combination of these applied cognitive and adult development psychology that suggests solutions into how to teach complexity, such as the approaches suggested at the end of this paper. Rather than provide a complete and finished solution, it is hoped that this paper will ignite a discussion around the specific challenges faced in the teaching of complexity and the solutions that the section can move toward by bringing together different psychological narratives to understanding the problem facing educators in this field.

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