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ANTIFRAGILE LEARNING: BLACK SWANS TO GREEN SWANS

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INTRODUCTION

The practice of Learning Design faces challenges from an exponential rate of global change, and a need for learning to be future-fit. In meeting these challenges, the design of learning can be viewed as a leadership practice that has the potential to have significant positive impact. If, as designers of learning we are not maximising the positive impact available to us, then we become part of the problems of both today and tomorrow. We can choose to be the ones who say do "look up" (McKay, 2021).

This article describes how the future is generally viewed within the practice of Learning Design, and identifies some issues in light of our increasingly unpredictable world.

THE CURSE OF THE MEAN AND THE NORMAL

To create future-fit learning that will be effective and prepare learners for the future, we need to gain some insights into potential future events. When determining the risk of future events, we tend to look to the past to draw conclusions for the future (Snowden, 2011). We tend to anticipate future events based on the frequency at which they have previously occurred and estimate the magnitude of those events based on previous magnitudes (Arthur, 1994). The more frequent occurrences are, the more likely they are to reoccur. We assume what can be described as a *Gaussian* approach, which suggests that we see these events, at least anecdotally, in the context of a normal distribution or bell curve (Newman, 2005). Viewed through a Gaussian lens, negative events fall at one end of the x-axis and positive at the other (Figure 1). The closer to the apex of the bell curve, the higher the perceived certainty that the event will reoccur. The more pronounced the apex, the higher the likelihood of a few events, the flatter the curve the greater the range of likely events. Focussing on the apex allows us to capture most past and likely future events.

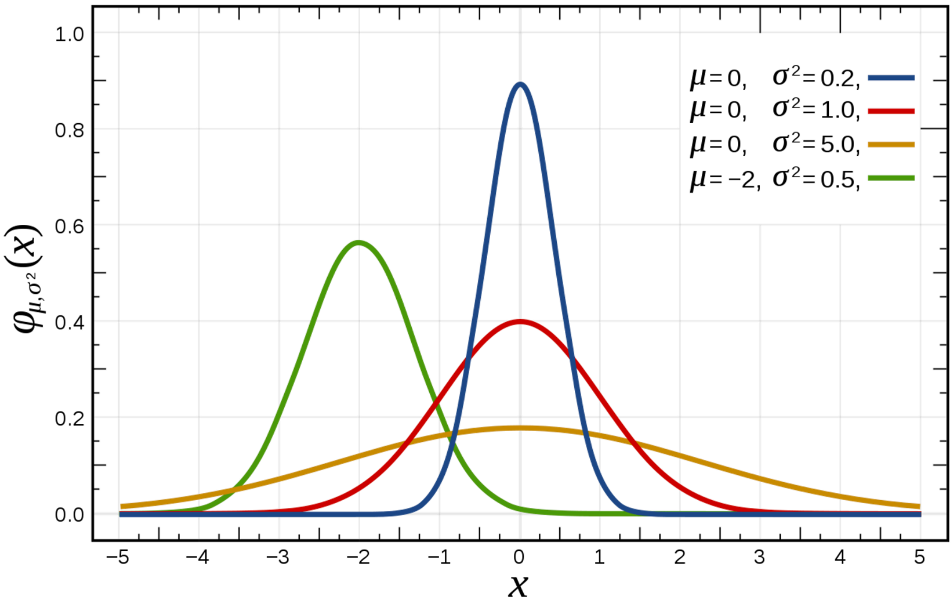

Figure 1. Examples of normal distributions (By Inductiveload – self-made, Mathematica, Inkscape, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3817954).

Therefore, when we are designing learning experiences, it is likely that we are designing for the majority of participants who sit close to the mean. This heightened attention to the mean is not a long stride away from the colonial notion of prioritising for the *greater good* (Hayes & Heit, 2018; Haykin, 2011; Mallon, 2019; Menzies, 2014). As our eyes track away from the tails of the distribution, the lower likelihood of reoccurrence, the smaller magnitudes, and defined confidence levels reassure us that those events are less worthy of attention in a predicable *normal* world.

However, due to rapid technological developments, exponential demographic change, global mobility, ecological disasters, and geopolitical trends that disrupt our lives at an ever-increasing rate, our future seems better described in the notion of a *VUCA World* than a *Normal World* (Hadar et al., 2020). The acronym 'VUCA' was first developed by the US War College to define conditions military leaders were encountering in the modern battlefield, but is now more widely used in leadership and management (Horney et al., 2010). The acronym refers to the characteristics of *Volatility* (the nature, speed, and volume of change); *Uncertainty* (the unpredictability of issues and events); *Complexity* (the interdependence of issues and surrounding factors); and *Ambiguity* (the multiple ways that conditions can be interpreted) (Cousins, 2018). With an increasingly VUCA world, we are also likely to encounter more extreme events than can be explained by the small tails of a normal distribution. We are perhaps heading towards a world better described by a Pareto distribution – a *Paretian World* (Hagel, 2007).

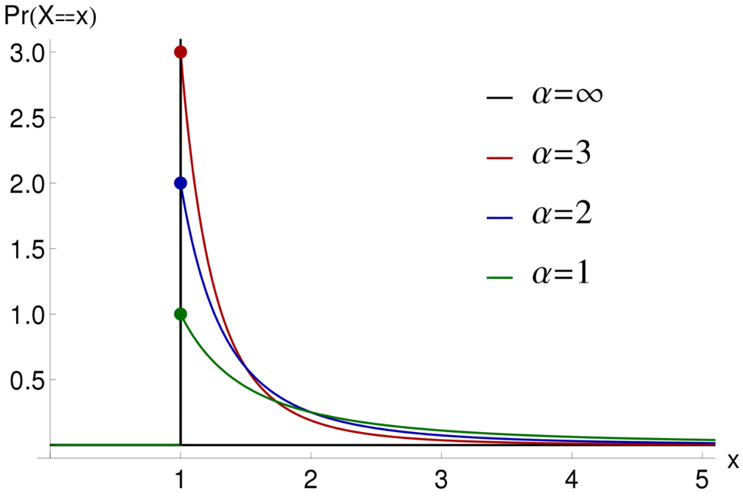

Figure 2. Examples of Pareto distributions (Danvildanvil, CC BY-SA 3.0, https://creativecommons.org/licenses/by-sa/3.0, via Wikimedia Commons).

Figure 2 demonstrates that a Pareto distribution differs fundamentally from the Gaussian normal distribution we are so enamoured with. While popularised by the well-known heuristic of the 80/20 rule (Juran, 2005), the origins of the Pareto distribution comes from the work of Villfredo Pareto in the late 1800s (Koch, 2011). Pareto distributions are power-law probability distributions which describe the relationship between two quantities where a change in one quantity results in a proportional change in the other (Hagel, 2007). Pareto's distribution was initially used to describe the distribution of wealth where a large proportion of the total wealth (80 per cent) is held by a small proportion of the population (20 per cent) (Newman, 2005). It has been found useful in describing phenomena such as social change, quality control, project management, and geophysical events such as earthquakes. McKelvey and Andriani (2005) describe the two approaches as differing radically.

Firstly, Gaussian distributions assume independence between the events. For us looking to the future, this means we would have to accept that the likelihood of one event has no impact on the likelihood or magnitude of another, and that there is no cumulative effect. In contrast, a Pareto distribution assumes that events are interrelated and cumulative. Not only are they interrelated but the relationship is fractal (Shirky, 2011). This fractal relationship means that the phenomena scales across the distribution and is apparent at any scale. For example, connectedness in social networks demonstrates a very high proportion of connections coalescing with a relatively small number of highly connected individuals. If we look at the subgroup of highly connected individuals, the same power law applies to the proportion of connections coalescing with a relatively small number of individuals within that highly connected group (Watts & Strogatz, 1998). This pattern repeats fractally.

Secondly, Gaussian distribution is characterised by its mean and variance, while Paretian distribution does not show a stable mean or variance. Paretian distributions have no meaningful average that can be assumed to represent the typical features of the distribution and no finite standard deviations upon which to base confidence intervals. Our eyes track to the tails of the distribution, not because we want reassurance of their insignificance, but because in the *fat tails* of Paretian distribution, extreme events are exposed as much more significant (Snowden, 2011).

The intent of this work is not to provide a mathematical analysis, but rather a more heuristic comparison of these two approaches in relation to learning design. It is clear that as designers of learning, if we always assume a normal distribution when planning for the future, we will underestimate the potential likelihood or magnitude of *tail events*.

So what are the implications for designing learning as we shift towards an increasingly VUCA world? McKelvey and Andriani (2005) contest that "No statistical findings … should be accepted if they gain significance by some assumption device by which extreme events and infinite variance are left out of the mix" (p. 226). Therefore, whether as a statistical technique or a helpful heuristic, Pareto shines a light on the highly improbable (VUCA) events to which we are becoming increasingly exposed if our visions of the future are induced by data or insights from the past.

THE FLAWS OF INDUCTIVE REASONING

When interpreting current and past events to draw inference about future events we are applying inductive reasoning (Haynes & Heit, 2018). Inductive reasoning is when "theories are formulated by drawing general inferences from particulars or cases of empirical data" (McAbee et al., 2017, p. 278). In a learning design context, it is the manner in which we use insights from past learning to inform the design of future learning. One issue with the application of inductive reasoning has been described as Hume's Problem, after the Scottish enlightenment philosopher, David Hume. In his *A Treatise of Human Nature*, he disassembles the basic assumptions of induction:

> … there is nothing in any object, consider'd in itself, which can afford us a reason for drawing a conclusion beyond it; and, That even after the observation of the frequent or constant conjunction of objects, we have no reason to draw any inference concerning any object beyond those of which we have had experience. (Hume, 1882, p. 436)

Yet, when generating design insights or developing strategy, data from past events and experiences tends to shape forecasts and design. By Hume's assertion, neither the frequency nor magnitude of past events or trends provide any certainty of them being representative or predicative of the future. Another issue with our dependence on inductive reasoning is that it creates epistemological bias (Hayes & Heit, 2018). The experience, data and process of interpretation caries perspectives and values from specific world views. The *priori* given to one world view over another represents a level of epistemological injustice, where some systems of knowledge are not equitably recognised (Fricker, 2013). Taleb (2008) describes this injustice as the "Great Turkey Problem" (p. 93); inductive reasoning would provide the Christmas Turkey with significantly different insights to the future than it would provide the butcher!

Greenfield (2020) provides a poignant example of this in highlighting how easily forecast the economic impact of the breakdown of planetary systems has been. Food failures, country debt defaults, failed states, wars, famine, pandemics, disease, mass migration, and mass extinctions are all more predicable if your inductive reasoning is based on observations and experience from a planetary systems perspective rather than through financial markets (referring directly to Taleb's prior career). Significant world events are epistemologically opaque from one world view, and transparent from another.

Not only are we exposed to uncertainty through over reliance on Gaussian thinking, but even when we recognise the higher probability of extreme events in a Paretian world, we are still subject to epistemic and philosophical biases which may render us blind to significant aspects of the future, blind to the potential damage of the highly improbable.

THE DESTRUCTIVE IMPACT OF THE HIGHLY IMPROBABLE – BLACK SWANS

Throughout history we have been challenged by the impact of the highly improbable. Through our own fragility, these events have exposed us to significant harm. Nassim Taleb describes these events as Black Swans in reference to the once widely held western belief that all swans were white. The capitalisation of Black Swan was adopted by Taleb to signify the difference between the birds in the metaphor from the events he was describing (Taleb, 2008). Despite centuries of reinforcement, it only took one sighting of a black swan to destroy that belief system. Black Swans are the unknown unknowns (Sutton et al., 2019). Black Swans share a trifecta of characteristics. Firstly, these extreme events are outliers from our usual expectations. Secondly, they create an extreme impact. Thirdly, they are retrospectively explainable and predicable (Taleb, 2008).

Many of the events commonly referred to as Black Swans emerge from our economic systems, noting of course the complex relationships between our economic life and other aspects. For example, the impact of hyperinflation in Germany post the First World War contributing to the conditions for the rise of Nazism, the bursting of the Dot Com Bubble in 2000, the post 9/11 market crash, and the 2008 Global Financial Crisis (Phadnis et al., 2021; Roselli, 2021; Sengupta, 2020). Other Black Swans include natural disasters such as earthquakes and hurricanes (Hobbs, 2019). However, it is not necessarily the physical or economic effects that determine the impact of a Black Swan. An example of the ugly social and cultural aspects of these natural disasters is all too visible in the vile racism of Strom's account of Hurricane Katrina (Strom, 2016). It is perhaps on these intersections of social, economic, and environmental that the impact of the Black Swan is most acutely felt, and the learning designer has a responsibility to make a difference.

However, the extent to which Black Swans are completely unpredictable or unknown unknowns is highly subjective. As mentioned earlier, this is in some part due to the epistemic bias in the inductive reasoning we use to account for the future within learning design. The thing that we can and cannot see due to our own world views. Within the Tiriti-based context of Aotearoa New Zealand (Treaty of Waitangi) epistemic injustice is evident in situations where traditional Māori knowledge (Mātauraka Māori) is insufficiently considered as an input for inductive thinking. Weaving Mātaraka Māori into thinking may increase the likelihood that what otherwise will be considered a Black Swan event could be forecast (Gilbertson, 2019; Rangitauira, 2021). Traditional knowledge is storified in pūrākau (traditional stories) to carry it through generations in a culture with a strong oral tradition. Environmental knowledge can be embedded into such stories as a taniwha. Taniwha are creatures often depicted as guardians, and the pūrākau surrounding them provide some insight into events beyond human memory or most western notions of scientific record.

Very public examples, where Mātauraka Māori was ignored with significant detrimental effect, illustrate the importance of incorporating diverse knowledge into design and decision making (McConnell, 2019; Morgan, 2011). One example involves the flooding of a motorway construction site, which encroached upon the dwelling of the water Taniwha Karu Tahi, causing the route of the road to be diverted. This led to a politician's previous statements on the matter looking somewhat ill-informed and foolish. Local Councillor Michael Laws (2011) stated "Taniwha do not exist. They are cute, cuddly legends – a brown fairy-tale. They belong in the same realm as dragons, leprechauns and the fairies at the bottom of the garden" (para. 15). This proved to be a misguided and prejudiced belief, which contributed to poor decision making, and a large cost to the rate paying public. The second example involves the construction of a prison which continues to sink into a swamp despite all the best available engineering advice (Ngawha Prison). The site had earlier been identified by Iwi as the home of the taniwha, Takauere. The project overran by NZ$100 million. Whether we look upon taniwha as manifestations of complex phenomena that are not well understood within narrow constraints of reasoning, or timeless ancestral creatures guarding the well-being of the land, it seems wise to ensure that they are included in the data that informs our inductive processes. The same data and processes that we use as inputs for designing learning.

In summary, inductive reasoning is based on experience and data from the past. Philosophically this does not determine whether the events are more (or less) likely to happen again in the future. However, in practice, the likelihood of many events is to some extent predictable, particularly those of high previous frequency that sit near the apex of a normal distribution. The events which sit further from the apex are however far less predictable, and the normal distribution less relevant. Even when examined using *fat tailed* distributions like Pareto, inductive reasoning does not inform the likelihood or impact of the highly improbable events of a VUCA world. The potentially destructive impact of Black Swans remains at least partially an unknown unknown. This leaves a blind spot in learning design that is unlikely to adequately prepare learners for the range of futures they may face, or the capabilities required to turn something negative into a positive – from Black Swan to Green Swan.

THE REGENERATIVE IMPACT OF THE HIGHLY IMPROBABLE – GREEN SWANS

John Elkington (1998) is best known for establishing the concept of Triple Bottom Line (social, economic and environmental impact) as a cornerstone of responsible business. However, in 2018 he issued a recall on the concept (Elkington, 2018). The core reason for the recall being that the concept had not achieved the radical change intended. It had been adopted as an accounting mechanism for a balancing act of competing agenda within a business as usual context. The triple bottom line approach sat comfortably within a Gaussian normal world: it had not changed the DNA of capitalism. It had fallen short of its potential to create disruptive system level change. Inspired by Taleb's Black Swans, Elkington (2020) proposed the concept of *Green Swans* as an alternative means to transform capitalism. Green Swans are profound shifts that are generally catalysed by some other disruption such as Black Swans. Exponential progress is evident in social, environmental and economic domains in a manner more akin to a Paretian approach. The progress represents an integrated breakthrough at a system level.

The climate crisis that we currently face is arguably a Black Swan which has catalysed several Green Swans. Climate change has and will for some time to come, present us with some of the most wicked problems humans have faced. Wicked problems are complex problems which cannot be definitively described, and that do not have definitive and objective solutions (Rittel & Webber, 1973). A climate-related example is how we replace our current travel behaviour with something that addresses the challenges of the climate crisis. Green Swans that are emerging as solutions to this include the transformation of large fossil fuel companies to renewable energy companies and the subsequent reinforcing loop from the financial markets (Pickl, 2019; Van de Graaf, 2018), the rapid adoption of electric vehicles (Kumar & Alok, 2020), and the increased value placed on natural carbon sinks such as bio-diverse forests (Di Sacco et al., 2021). Three Green Swans born from one Black Swan, all interrelated and dependent. When viewed within the context of the COVID-19 pandemic which has reduced all forms of travel, and potentially primed the world population to be more plastic to change, we begin to see more alignment with the cumulative and inter-dependent perspective of a Paretian world. There is nothing normal or average about Green Swans.

Indeed, it could be said that the VUCA world of swans and continually disruptive change is the new normal. A world where we may experience temporary states of stability but should no longer expect to experience equilibrium or normal distributions. So, how do we design learning in order to be better equipped to respond to Black Swans with Green Swans?

FRAGILE – RESILIENT – ANTI-FRAGILE

We have already explored the relationship between likelihood of events and how we perceive our exposure to their negative impacts. However, this risk is based entirely on the inductive reasoning described earlier. The closer to the tail of either the normal distribution (if we remain wedded to it) or the Paretian distribution, the lower the number of data points and therefore the level of confidence we can have in the validity of the prediction. An appropriate example of this is the increasing frequency at which we see one in one-hundred-year weather events (Naumann et al., 2018). Therefore, the risk of Black Swans is not something we can easily describe. However, the extent to which the event would adversely impact us, is more easily described. We can instead ask to what extent we are *Fragile* to the event.

While fragility has technical meaning in a range of scientific contexts (Novikov et al., 2005), it is sufficient here to assume that when something is fragile it is easily broken when subjected to pressure or stress. A fragile system will likely exhibit extensive uniformity, have little tolerance for diverse conditions, be slow to change, intolerant of ambiguity, and dependent on predictability (Taleb, 2014). An example of fragile learning design might be the highly linear, content- and process-orientated designs implemented in higher education accountancy courses. Due to disruptive technological advancement, automation and changing client expectations, the required capabilities have shifted towards a more human centred business advisory role (Bowles et al., 2020). This has led to significant criticism of the existing courses, which seem slow to change. Major employers have stepped in to take responsibility for the training themselves (Havergal, 2015).

It seems at first that fragility may be the opposite of resilience or robustness. However, *resilience* has other implicit concepts that differentiate it from fragility. One definition of resilience is the rate at which a system returns to equilibrium following disturbance (Resilience and Sustainability, 2019). The higher education response to COVID-19 has provided examples of learning design which shows characteristics of resilience. For example, courses that have adopted a flipped classroom model with content and resources available online of pre-face-to-face sessions, will likely have adapted more easily to the challenges of lockdowns, when compared to their more traditional lecture-based equivalents. It would also be fair to assume that they will find it easier to bounce back to their normal mode post-lockdown (Mehta, 2020; Roy et al., 2020). This view assumes that a system has equilibrium conditions and a single state to bounce back to. Whereas fragility is based on being either stable or unstable. There is no notion of bouncing back to equilibrium, but rather moving through various states of stability and instability.

Robust, however, has a closer alignment with fragile. A robust system will withstand greater pressure or stress and hold its form. It is a system that is less likely to break. If we look to historical and traditional institutions or to deeply embedded tradition of disciplines, we see learning designs that have so much inertia that they just cannot be moved, even by high disruptive global events (Christensen & Eyring, 2011). Robust, however, is not the opposite of fragile in that it merely maintains the state of the system and does not change it in the opposite direction of fragility. To be the opposite, the system must be improved by the pressure and stress. This is what Taleb (2014) describes as *Antifragile – things that gain from disorder.*

Anti-fragility is the quality of a system that is stronger or better due to exposure to shocks, and disruption. At one level, it is the human body that gains strength rather than breaks from lifting weights in a gym. Taken a level further, it is the elite performance of Eliud Kipchoge running a marathon in under two hours after a life time of high altitude, fast-pace training (Joyner et al., 2020). In Taleb's persistent use of mythology, it is the Hydra which grows a second head when you cut one off. In technology, it is the artificial intelligence system that improves through errors rather than fails. In business, it is the fail fast entrepreneurial ecosystem, rather than the large bureaucratic organisation.

In learning design, we find examples of anti-fragile design when work-based learning is designed with heutagogical principles (Mann et al., 2017). If we look to Capable New Zealand, the work-based learning school of Otago Polytechnic, the high level of student-determined learning allows learners to maximise the learning available in disruptive circumstances, rather than be limited by them. For example, the Bachelor of Leadership for Change is a post-disciplinary bachelor's degree based on heutagogical principles and enables learners to shape their study around their desire to lead change. One student shaped their entire programme around developing the competences to avoid them being automated out of a job (again). Their learning experience was more valuable because of a highly disruptive force.

The wicked challenges we face as we work towards the United Nations Sustainable Development Goals (SDGs), offer opportunities for anti-fragile learning (Sustainable Development Solutions Network, n.d.). Some of the best examples of this are where the learning design incorporates a living lab approach (Graczyk, 2015; Leal Filho et al., 2020). Within the living lab approach, students are subjected to the impacts of sustainability challenges as members of the university community (the lab), they conduct research of projects to inform or implement solutions, which in turn influence longer term practice. The challenges, the lived experience, and the authentic outcomes all offer an enhanced learning experience rather than one diminished by the disruptive challenges. From my own practice, establishing a sustainability neighbourhood as a living lab where students have the support and freedom to work as a community to solve sustainability problems is well aligned with the concept of anti-fragile learning (Australasian Campuses Towards Sustainability, 2022).

Whatever the context, there is capability to embrace small failures due to unpredictable events and use them to improve the system; to empower learners to enhance their own learning, by addressing big challenges and learning from the process. Anti-fragility is the condition where there is benefit gained through an unpredictable and disruptive occurrence. In its most simple form, an anti-fragile system is a system that is good at learning.

CONCLUSION: ANTI-FRAGILE LEARNING

So, we have established that focussing attention on the apex of a normal distribution has limits in anticipating the challenges of the future. Those challenges are becoming increasingly VUCA, and our epistemic biases narrow our understanding of them. We know that Black Swans (and Taniwha) sit ready in the long tails of the distribution. We should therefore have diminishing confidence in our ability to predict what the future holds. We can however prepare by focussing on the extent to which we are fragile to these events.

As designers of learning we can address this on two levels. Firstly, we can look at the design of the learning experience itself and how fragile it might be to disruption. Secondly, we can look at the extent to which the learning outcomes are anti-fragile. For example, what extra learning have learners been able to access as a result of the pandemic? In other words, are we creating the opportunity for learners to be the creators of the Green Swans of the future?

If we look at heutagogical design, learners have significant control of both the design of the experience and the learning (Blaschke & Hase, 2016). This may offer us the opportunity to create anti-fragility on both levels. But is current practice well aligned with looking to the future in this way? If not, then as learning designers, we must reflect upon whether we are meeting our responsibilities to contribute to a thriving future – to activate the leadership potential of learning design.

Ray O'Brien is the Tumuaki o Toitū te Taiao or Head of Sustainability at the University of Otago. He has responsibility for delivering on their Sustainability Strategic Framework. This gets him involved with operations, teaching, research, and community engagement across the University. His research interests centre around the design of learning experiences that support learners in an increasingly complex and unpredictable future – designs that realise the leadership potential of learning designers.

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