JOURNAL OF ORGANISATIONAL TRANSFORMATION & SOCIAL CHANGE, Vol. 12 No. 1, April, 2015, 42–56

Reciprocity and Resilience: Teaching and Learning Sustainable Social Enterprise through Gaming

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Against a backdrop of increased global environmental and economic uncertainty, the resilience and sustainability of urban communities is a paramount concern for decision makers. The work presented here aims to explore how teaching and learning around transition initiatives, based upon social enterprise and reciprocity, might be supported by game theory and strategy simulation environments. Key elements for this are the co-evolutionary nature of internal and external organisational contexts. The gaming prototype developed here (Exploring Community Resilience, ExCoRe) is based upon an extension of the Prisoner's Dilemma as a medium for active learning, but is enacted through a multi-player and dynamic environment. The key learning objectives for the game are to introduce a broad concept of reciprocity and collaboration on a systems level, and the importance of an emergent and responsive 'learning strategy' for new start-ups and enterprises. The static nature of the traditional strengths, weaknesses, opportunities, and threats (SWOT) approach is challenged and students are encouraged to appreciate, through establishing game strategy, a much more fluid and dynamic relationship between internal and external environments.

KEYWORDS resilience, reciprocity, social enterprise, evolutionary approaches, prisoner's dilemma, game theory, complexity, crowd behaviour

Introduction

The concept of resilience from an ecological perspective may be described as the ability of a system to recover from shocks or disturbances and maintain

 DOI 10.1179/1477963314Z.00000000034

equilibrium (Pisano, 2012, referring to Hopkins, 2010). Resilience is a multi-faceted concept and earlier studies looking into resilience have focused extensively on phenomena exhibited in nature, especially from biological systems (Bhushan, 2009; Levin et al., 1998; Matsinos & Troumbis, 2002; Pierce et al., 2005; Santoli, 2005). Cellular processes such as metabolism, growth, and replication are carefully regulated in the biological world due to the following typical features:

- specialisation of function, often by self-contained organelles
- communication between independent entities within the cell
- detection and response to environmental (external) conditions
- efficient resource allocation within the cell to maximise survival and growth
- complex webs of interaction, which are robust to perturbations
- excess capacity to enable responsiveness
- tolerance of changes such as mutation of DNA.

These characteristics of cells have allowed them to maintain stable internal environments and successfully adapt to changes in the external environment. These adaptations can occur on short time scales via signalling mechanisms, or on longer time scales via variation and selection (Kacser & Burns, 1973; Wagner, 2005). After considering community resilience within a societal context, Dale et al. (2010) concluded that important characteristics for sustainability include a community's networks of connections, its ability to innovate, and then respond and react to change. Some interesting parallels may be drawn here between these characteristics and those identified for cellular resistance, particularly in terms of tolerance to changes, complex webs of interactions, communication between entities, and excess capacity.

Common notions of resilience tend to rely on the system's ability to *recover* from shocks or stress and maintain equilibrium (Martin, 2012). This definition of resilience is heavily influenced by natural science and has several drawbacks when applied to social systems. Fundamentally, it does not take into account non-linearities, and assumes linear profiling of disturbances whereby a system is expected to retain its original state after undergoing disturbances. Typical social-technical or social-eco systems are complex systems, characterised by multifarious interactions, webs of networks, and unexpected response states. Returning to equilibrium simplifies the notion of resilience and does not adequately capture the depth of the phenomenon. Additionally, shocks and disturbances can cause irreversible shifts in the system state, which initiate permanent changes in the otherwise persevering system. Extensive studies have focused on exploring the resilient characteristics of ecosystems and their responses to changes in environmental conditions, particularly themes of response diversity, ecosystem reorganisation, self-organisation, replication, learning, and adaption (Hopkins, 2010; Lélé, 1998; Smith & Stirling, 2008, 2010). In this sense, resilience may be seen as a process of reconfiguring institutional structures to develop new abilities for maintenance and growth (Boschma, 2014). This study is a further extension in this domain, focusing on investigating the responses of community systems when encountering disturbances or shocks. It specifically aims at studying the resilience of community systems subject to disturbance and their ability to reorganise, renew, and express an ability to learn and adapt — characteristics already identified as intrinsic to community sustainability (Dale et al., 2010). This conception of adaptive resilience is coherent with evolutionary approaches to social systems (see, for example: Abatecola, 2013; Aldrich, 1990, 1999; Aldrich et al., 2008; Breslin, 2011; Dobson, 2012; Hodgson & Knudsen, 2010; Stoelhorst, 2008).

The pedagogic challenge here is that students accustomed to traditional strengths, weaknesses, opportunities, and threats (SWOT) thinking are ill-equipped for developing strategies which consider the co-evolutionary relationship between internal resource management (for the purposes of consumption and production) and its symbiotic relationship with the external environment (or causal texture). The approaches of both strategic fit and strategic stretch tend to individualise organisational entities and contain a number of strategic management paradoxes as identified by Price and Newson (2003), namely: intended (deliberate) versus realised (emergent) strategies, revolutionary versus transformational strategies, and strategy versus organisational effectiveness. The result often can be a relatively static view of the organisational context and 'messy' real-world solutions seem to sit outside of this oversimplification of the organisation and the business environment which it operates within. Instead, the work presented here aims to explore a pedagogic approach which:

- engages the learner in a changing environment
- encourages strategic thinking on a community or system-level
- blurs the distinctions between competitors and collaborators, and
- requires a 'learning strategy' approach while appreciating the close and continually changing relationship between internal and external factors.

This article reports on interdisciplinary work undertaken to develop game-based learning to illustrate broad concepts of reciprocity and collaboration and the importance of an emergent and responsive 'learning strategy' (Mintzberg et al., 1998) for new start ups of social enterprises within the context of sustainable and resilient urban communities. The game — called Exploring Community Resilience (ExCoRe) — is not intended to provide a formal simulation of business start up and management, as may be found elsewhere (e.g. GoVenture). Instead, the design is influenced by abstracted and analogous gaming environments aimed at demonstrating principles and processes rather than detailed scenarios. The initial design takes its departure from the popular game theory activity known as the 'Prisoner's Dilemma' (Axelrod, 2006; Axelrod & Hamilton, 1981; Marion, 1999; Price & Shaw, 1998). However, the need to visualise game play through a graphical game space was influenced by experiments with board-based complexity such as Conway's 'Game of Life' (Marrion, 1999; Nowak & Sigmund, 1993).

Design science (DS) is used here as the methodological framework for exploring the resilience of complex community enterprise relationships through game development. DS has its foundations in software engineering (Livari, 2007) and has evolved into a research methodology transcending disciplinary boundaries and domains. Essentially it is a problem-solving paradigm used in developing innovations, practices, and products through an iterative cycle of analysis, design, and implementation (Hevner, 2007). Although the methodology was initially focused on developing and managing information systems, it has further evolved to address issues in other disciplines (such as in business model development, see Osterwalder, 2004).

The DS methodology is characterised by three main cycles or interconnecting stages: the design cycle, the relevance cycle, and the rigour cycle. The project, as a research environment, is underpinned by the 'relevance cycle'. This cycle characterises the contextual environment and provides the route for DS activities to build and develop artefacts in a practical context. The knowledge base, which is characterised by theories, expertise, or experience, is captured within the 'rigour cycle'. This cycle connects the design activities with the domain's knowledge base. The final 'design cycle' links theory and practice by iterating between developing the artefact/system and the research process/knowledge base (Hevner, 2007).

The study presented here aims to engage students with strategic thinking in the pursuit of achieving a robust and resilient system-state based on reciprocity. The 'community' of entities simply consists of virtual game pieces moving around the screen consuming resources to survive and so engages with the subject on an abstracted level.

The gaming approach

Theories of games have provided valuable lessons through analogy and abstraction and have been used extensively as a way of articulating the emergent learning strategies of adaptation and collaboration in human decision making (Marrion, 1999; Price & Shaw, 1998). Axelrod and Hamilton (1981), for example, applied game theory to study the evolution of cooperation in 'selfish' individuals, while Williams' (1966) work expanded game theory to analyse human behaviour. While using analogy from biological resilience for the study of community resilience presents theoretical benefits, it also provides challenges in equal measure. Exploration through active gaming can generate a unique opportunity for evaluation and ontological scrutiny through the practice of development and learning. This is consistent with DS approaches to creative development (Hevner, 2007; Livari, 2007; Osterwalder, 2004). Since the product being developed here is an educational tool to support teaching and learning there are strong parallels between the evolutionary prototyping process of software design via a DS framework and the development of thinking around learning and curriculum development (see: Bloom, 1956; Pinar, 2004; Sheehan, 1986; Tyler, 1949; Wheeler, 1967).

The initial point of development for the game is its exploration and promotion of collaborative and reciprocal behaviour in the formation of interdependent social enterprises. A 'social enterprise' is broadly conceived here as comprising a collection of actions, whether formal or informal, undertaken by a social entity which is expected to introduce social capital into a social system. This is a necessarily 'broad' definition of entrepreneurship and enterprise as characterised by the Scandinavian mode of thought (Bjerke, 2013) rather than a 'narrow' Schumpeterian economic perspective.

To provide an enterprise model for community resilience through reciprocity, the game dynamic requires social capital investment from emerging alliances of enterprises to be enacted through a system of collaboration. The Prisoner's Dilemma provides a valuable framework here. Since its inception in 1944 by John von Neuman and Oskar Morgenstern, game theory has been extensively referred to in academic texts (Axelrod, 2006; Axelrod & Hamilton, 1981; Marrion, 1999; Price & Shaw, 1998). From a learning perspective, the Prisoner's Dilemma has proved highly effective in developing an appreciation of the following:

- the organisational structure might promote Prisoner's Dilemma situations
- cooperation strategies as opposed to individually-optimal strategies are more successful over multiple transactions
- notions of 'implication effect' and self-defeating behaviour.

From a strategist's viewpoint it might be argued that game theory encourages a 'learning school' (Mintzberg et al., 1998) perspective. In this sense, the strategy for playing is not planned or designed in a prescriptive sense, but is instead responsive to the opponent's strategy. Jermy (2011) identifies that the learning school is based upon the primary assumption that: '[...] strategies emerge as people, sometimes acting individually but more often collectively, come to learn about a situation as well as their organization's capability of dealing with it [...] Eventually they converge to patterns of behaviour that work' (Jermy, 2011: 123). The main premise of the learning school is that 'complex environments preclude deliberate control [and that] strategy making must above all take the form of a process of learning over time in which, at the limit, formulation and implementation become indistinguishable' (Jermy, 2011: 123). Therefore, the ability to learn collectively is an important characteristic for communal resilience and so the creation of a gaming environment which can promote multi-player convergence of behaviour underpins this work, as outlined later in this article.

The potential for the Prisoner's Dilemma to be used to teach collaborative action depends largely on the utility (i.e. the nature of the reward) and the utility map (i.e. the level of the reward and value differentiation between selfish and collaborative action). Normally these are fixed at the outset of the game and are explicitly known by each player, but it was important for this work to depart from these rules in three key ways:

- utility must comprise both financial *and* social value
- utility must incorporate uncertainty and so explicit value should be unknown to players
- the utility map should change over time to reflect differing funding environments.

Since the game is designed to be broadly representative of an urban system, the three axes — which Chelleri and Olazabal (2012) identify as important for urban community resilience and innovation — provide a valuable framework. Here they suggest that: '[...] extensive dependence on external resources hinders the capacity of cities to contain environmental impacts within their own boundaries' (Chelleri & Olazabal, 2012: 8). According to Chelleri & Olazabal (2012), resilience is considered as being dependent upon:

- maximised efficiency of resource use, since cities are often characterised by inefficient energy and resource metabolism
- the decoupling of resource use from economic activities (Weisz & Steinberger, 2010), given that 'neither energy nor materials are needed for the satisfaction of certain needs, but services, and that these services should be rendered with

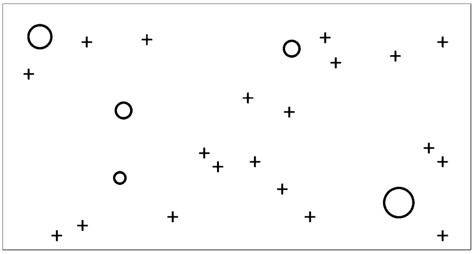


FIGURE 1 Schematic representation of the initial business environment or causal texture made up of available finances (+'s) and players (o's).

the least amount of material and energy investment' (Fischer-Kowalski & Huttler, 1998: 120) — which leads back to our first axis and eventually to

- promotion of self-sufficiency and reduced external dependence in conjunction with the mitigation of local vulnerabilities to specific shocks (e.g. the case of local energy resilience in O'Brien & Hope, 2010).

Game play

In order to replicate the rounds of the Prisoner's Dilemma, whereby a player may choose to change strategy, the game was seen to require a similar mechanism to facilitate change in enterprise behaviour through learning (Breslin & Jones, 2012). This should be applied as a set of incremental refinements (Lindblom, 1959) in response to the causal texture or business environment within which the enterprise would be operating, in addition to the varying levels of reciprocal behaviour demonstrated by the other enterprises (or 'players').

The start

Before play starts, the screen displays the initial business environment or causal texture (Figure 1). This is made up of randomly distributed shapes ('+'s) which represent available funding and finances. Numerous players may enter the game space (each player represented by an 'O'). This defines the external environment, which is made up of opportunities (extensive finances and few competitors) and threats (few finances and extensive competitors).

Once entered into the game, the players' enterprises randomly move around the screen. Energy levels, which start the game at 100 per cent, deplete over time and eventually will reach 0 per cent if not replenished, resulting in the death of the enterprise. If the enterprise happens to move over a '+' ('finances') its energy increases, thus sustaining it for longer. If the energy level of the enterprise reaches zero it dies, and so the purpose of the game is to survive for as long as possible. *Each player cannot directly control the path that their piece takes around the screen.* The only control a player has is through an initial allocation of resources (strengths and weaknesses), which influence the following ways in which their piece will move and behave on the screen. This represents a process of assessing the desired strengths and weaknesses in relation to the perceived environmental opportunities and threats. The player must choose which of the following four characteristics to emphasise:

- *Speed of movement around the screen (i.e. slow to fast):* higher speeds result in more rapid energy depletion but may increase the chance of bumping into finances.
- *Extent of coverage around the screen (i.e. limited to extensive):* extensive coverage results in more rapid energy depletion but may increase the chance of bumping into finances.
- *Metabolic rate:* this determines how efficiently the enterprise can convert the utility, e.g. finances, into energy, thereby replenishing the enterprise more effectively.
- *Amount of social capital output by the enterprise:* players may choose to *output* social capital which is indicated by the presence or absence of a trail left behind the piece as it moves around the screen ('x's). Choosing to output social capital results in more rapid energy depletion. *However, social capital is also a utility which replenishes the energy of others in the same manner as finances.*

Environmental 'shock'

The 'finance' utility is programmed to fade and disappear over time, thereby eventually requiring players to solely consume social capital to survive. If all players started the game selfishly (i.e. choosing not to output social capital) they have the opportunity at various time steps to alter their allocation of resources. Therefore, they may subsequently choose to output increased levels of social capital trails to the detriment of other characteristics. Obviously, they will hope that the other players follow suit!

Findings

To explore the value of ExCoRe as a teaching and learning tool, tests with two undergraduate business and management student groups are reported below. As noted, the fundamental basis of this article is an application of game theory and an extension of the Prisoner's Dilemma scenario. ExCoRe is fundamentally a strategic decision-making game wherein survival relies on social cooperation and interaction with neighbours. Nowak and Sigmund (1993), in their experiments on cellular automata, noted strategies adopted by players when confronted with choice scenarios. In their simulations, they noticed that, after several rounds (generations) of play, certain forms of strategic choice patterns emerged: players either tended to cooperate for mutual benefit or tended to defect based on selfish motives. In this sense, two types of players emerged: pure cooperators and pure defectors, based on the tendency of the players to form survival partnerships. For example, they noticed that lone cooperators were exploited by defectors, whereas cooperators with strength (four or more) in numbers were able to tackle difficult situations with competence. Similarly, when there was a grouping of defectors, it acted to their detrimental effect. Eventually, after a number of iterations (generations), stability was reached in relation to the number of defectors and cooperators. This relative stability mirrors many other similar phenomenon occurring in the natural and social sciences associated with stability in complex systems (Langston, 1986; Marrion, 1999; Wolfram, 1984).

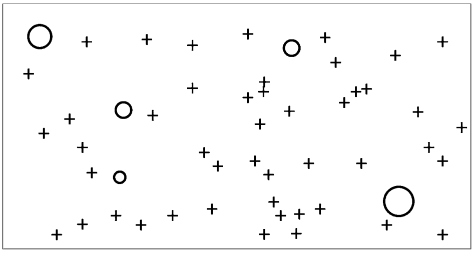


FIGURE 2 Game Scenario 1 – Abundant finances, all entities acting selfishly.

To simplify the evaluation of the game, the students were faced with the following commonly encountered strategic choice scenarios.

Scenario 1: abundant finances, all entities acting selfishly

The players within the ExCoRe gaming scenario define their profile (charitable to selfish). Their survival in the causal texture depends on the presence of finances, the number of similar profiles, and their management of social capital. If an enterprise decides to adopt a selfish profile then its survival is adversely affected by the number of other similar selfish profiles and enhanced by the presence of finances in the game space as well as the number of enterprises outputting social capital. If all profiles decide to act selfishly and limit their social capital spend then they might only survive in an environment where finances are plentiful (Figure 2).

Scenario 2: fewer finances, one entity outputting social value

Where finances are scarce and each player continues to act in isolation they will all struggle to survive. Even if the selfish enterprise decides to change its game dynamics to capture scarce resources and perhaps increase its spatial movement (in terms of speed and range) this will result in increased energy expenditure and more rapid depletion of its energy stores (Figure 3).

Scenario 3: almost zero finances

In order to ensure survival, the enterprise must rely on consuming the social value trails left behind by others. In the case of complete depletion of resources (financial), survival is solely based on support from other entities and so is a function of reciprocity (Figure 4).

As with the findings from multiple Prisoner's Dilemma rounds mentioned above, reciprocity is dependent upon negotiation between players. However, uniquely to ExCoRe, the multiplayer environment means that this may also occur as a learnt phenomenon through crowd psychology. Players observing others outputting social value trails may consider the benefits of doing likewise, thereby creating a snowballing of individual behaviours within the crowd. Significantly, this may create opportunities for predators as discussed by Marrion (1999) and Nowak and Sigmund (1993). Predators are defectors who benefit from a collaborative environment without having to contribute to it themselves. However, the creation of predators may also encourage others to follow suit and again create a

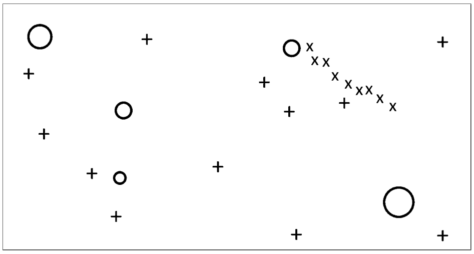


FIGURE 3 Game Scenario 2 – Fewer finances, one entity outputting social value.

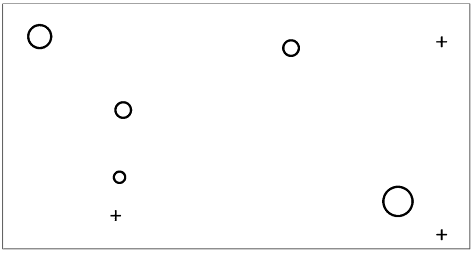


FIGURE 4 Game Scenario 3 – Almost zero finances.

snowballing effect of selfish behaviour. In this sense, stability will never be constant when there are many players and when they are unable to personally negotiate strategies, instead learning from observing the characteristics of others. Ultimately, the aim is to attain an 'edge of chaos' equilibrium (Langston, 1986; Wolfram, 1984) oscillating around events of punctuated equilibrium. This is where cooperation, negotiation, reciprocity, and dependence ultimately may lead to the formation of resilient enterprises, their survival, and, most importantly, the sustainability of the system of social cooperation within which they exist.

The compiled choices of strength/weakness allocation for each group over all three scenarios (listed above) was reported (see Figures 5 and 6). It was seen that, while there was little consensus as to the best strategy for survival in scenarios 1 and 2, scenario 3 overwhelmingly resulted in students opting for a shared rather than an individual-maximising strategy.

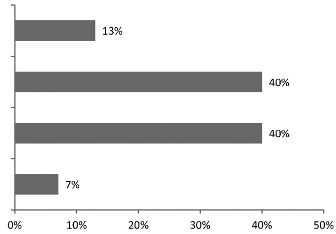
Conclusion

> Perhaps some would argue that this story illustrates evolution through the survival of the fittest, but the fittest were those that cooperated, not those that competed. In this context the phrase 'survival of the fittest' seems contradictory; 'emergence of the cooperative' seems a more apt phrase to rally about. (Marrion, 1999: 51)

This study started with the objective of helping students to appreciate the resilience of a system (collective) through reciprocity using a prototype virtual environment. The initial prototype was successful in envisaging how entities might interact with the causal texture based upon their profile settings and appears to have been successful as a communicative aid for learning. The seed entities survive based on how they are defined and adapt to move and absorb resources in the business environment (causal texture). Entity survival is essentially a function of dynamic responsiveness and a collective willingness to cooperate on the system level. The

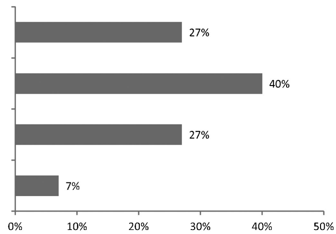
1.) Scenario 1 (Multiple Choice)

	Responses	
	Percent	Count
SPEED	13%	2
COVERAGE	40%	6
METABOLISM	40%	6
SOCIAL VALUE OUTPUT	7%	1
Totals	**100%**	**15**



2.) Scenario 2 (Multiple Choice)

	Responses	
SPEED	27%	4
COVERAGE	40%	6
METABOLISM	27%	4
SOCIAL VALUE OUTPUT	7%	1
Totals	**100%**	**15**



3.) Scenario 3 (Multiple Choice)

	Responses	
	Percent	Count
SPEED	20%	3
COVERAGE	7%	1
METABOLISM	0%	0
SOCIAL VALUE OUTPUT	73%	11
Totals	**100%**	**15**

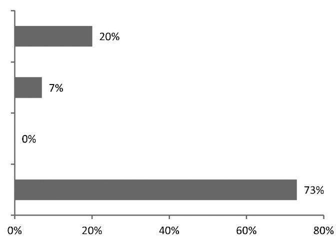


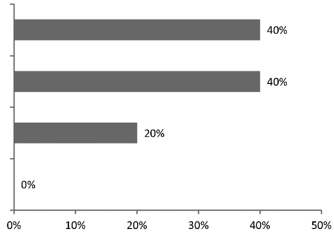
FIGURE 5 The compiled choices of strength/weakness allocation for all three scenarios (Group 1)

predominant choices made for scenario 1 compared to those made for the least-selfish scenario 3 are illustrated in Figure 7.

Finances are programmed to fade over time and eventually disappear from the game space. As identified in the introduction to this article, this represents an

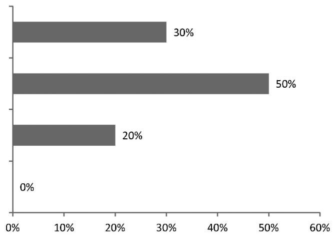
1.) Scenario 1 (Multiple Choice)

	Responses	
	Percent	Count
SPEED	40%	4
COVERAGE	40%	4
METABOLISM	20%	2
SOCIAL VALUE OUTPUT	0%	0
Totals	**100%**	**10**



2.) Scenario 2 (Multiple Choice)

	Responses	
	Percent	Count
SPEED	30%	3
COVERAGE	50%	5
METABOLISM	20%	2
SOCIAL VALUE OUTPUT	0%	0
Totals	**100%**	**10**



3.) Scenario 3 (Multiple Choice)

	Responses	
	Percent	Count
SPEED	0%	0
COVERAGE	10%	1
METABOLISM	10%	1
SOCIAL VALUE OUTPUT	80%	8
Totals	**100%**	**10**

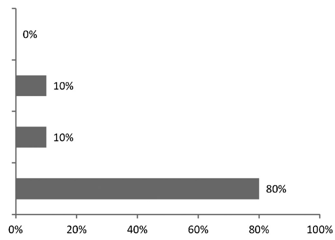


FIGURE 6 The compiled choices of strength/weakness allocation for all three scenarios (Group 2).

economic disturbance to which the enterprise's internal strengths and weaknesses (Figure 7) are reallocated by players in order to adapt. As such, the resilience and sustainability of the system are maintained, however, this is not achieved through a return to the original state. Instead, as Boschma (2014) identifies, this is achieved

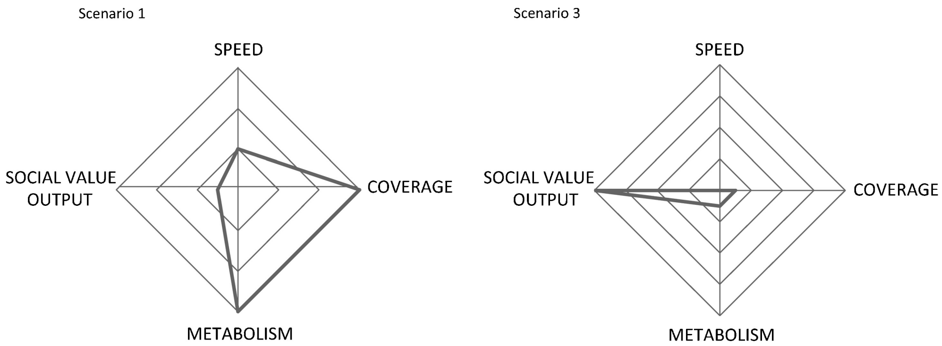


FIGURE 7 Key shift in allocated strengths and weaknesses between scenario 1 and scenario 3.

by reconfiguring institutional structures. On a community or systems level, resilience is illustrated to be reliant upon all participants reorganising, renewing, and expressing their ability to learn and adapt as suggested by Dale et al. (2010).

It was also important to express to the students that social value trails resulting from *internal* resource allocation inevitably form the causal texture of the *external* environment. As such the two have the potential to be symbiotically linked, a notion which is somewhat missing from their separation in traditional SWOT analysis. This simple gaming exercise also reiterates a continual and adaptive approach to enterprise strategy and we might consider it a successful teaching illustration since the change in strategy was overwhelmingly adopted by the students as reported in the findings.

Even at this stage, the developed prototype represents many DS cycles of development, justification, and evaluation of game rules and game dynamics at each conceptual stage. The necessary ontological scrutiny of values and assumptions within this process has provided insight into the Prisoner's Dilemma as a teaching and learning tool in the complex environment of community resilience. It is also envisaged that this extension to the Prisoner's Dilemma will open new research avenues into further work on complexity in crowd dynamics and evolutionary learning strategies of individuals and groups within the gaming environment. From a practical perspective, the recently introduced social value auditing (SVA) initiative also may benefit from the acknowledgement that a systems rather than enterprise-level assessment is necessary to appreciate effectiveness, thereby focusing auditing efforts, research, and pedagogy on resilience through reciprocity.

Acknowledgements

The authors would like to acknowledge the funding support from Sheffield Hallam University's Imagine Project: an annual investment in innovative interdisciplinary research.

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