Reciprocity and resilience: teaching and learning sustainable social enterprise through gaming

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Reciprocity and Resilience: Teaching and learning sustainable social enterprise through gaming

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Abstract

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 organizational contexts. The gaming prototype developed here (ExCoRe - Exploring Community Resilience) is based upon an extension of Prisoners' 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 at a systems level, and the importance of an emergent and responsive 'learning strategy' for new startups and enterprises. The static nature of the traditional 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, Prisoners' Dilemma, Game Theory, Complexity, Crowd Behavior.*

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1 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 equilibrium (Pisano, 2012, referring to Hopkins 2010). Resilience is a multifaceted concept and earlier studies looking into resilience have focussed extensively on phenomena exhibited in nature, especially from biological systems (Levin, 1998; Santoli, 2005; Matsinos and Troumbis, 2002; Pierce et al, 2005; Bhushan, 2009). 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 to successfully adapt to changes in the external environment. These adaptations can occur on short time scales via signaling mechanisms, or on longer time scales via variation and selection (Kacser and Burns, 1973; Wagner, 2005). On considering community resilience within a societal context, Dale et al (2010) conclude that important characteristics for sustainability include a community's networks of connections and its ability to innovate, and 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 of changes, complex webs of interactions, communication between entities, and excess capacity.

As described, 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, characterized 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 system state. These initiate permanent changes in the otherwise persevering system. Extensive studies have focused on exploring the resilient characteristics of eco systems and their responses to changes in environmental conditions, particularly themes of response diversity, ecosystem reorganization, self-organization, replication, learning and adaption (Hopkins, 2010; Smith and Stirling 2008, 2010; Lele, 1998). In this sense, resilience may be seen as a process of reconfiguring institutional structures to develop new ability for maintenance and growth (Boschma 2014). This study is a further extension in this domain; it focuses 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 reorganize, 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 (For example: Abatecola 2013; Dobson 2012; Breslin 2011; Hodgson and Knudsen 2010; Aldrich et al 2008; Stoelhorst 2008; Aldrich 1999, 1990).

The pedagogic challenge here is that students accustomed to traditional 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 trend to individualize organizational entities and contain a number of strategic management paradoxes as identified by Price and Newson (2003) namely, intended (deliberate) versus realized (emergent) strategies; revolutionary versus transformational strategies; and strategy versus organizational effectiveness. The result can often be a relatively static view of the organizational context and 'messy' real-world solutions seem to sit outside of this oversimplification of organization and the business environment which it operates within. Instead, the work presented here aims to explore a pedagogic approach which; 1) engages the learner in a changing environment, 2) encourages strategic thinking at a community or system-level, 3) blurs the distinctions between competitors and collaborators, and 4) requires a 'learning strategy' approach appreciating the close and continually changing relationship between internal and external factors.

This paper reports upon 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 startups of social enterprises within the context of sustainable and resilient urban communities. The game, called ExCoRe (Exploring Community Resilience), is not intended to provide a formal simulation of business startup 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 'Prisoners' Dilemma' (Axelrod and Hamilton 1981; Price and Shaw 1998; Marion 1999; Axelrod 2006). However, the need to visualize game-play through a graphical game-space was influenced by experiments with board-based complexity such as Conway's 'Game of Life' (Nowak and Sigmund, 1993; Marion 1999).

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, and is 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 characterized by three main cycles or interconnecting stages; the design cycle, the relevance cycle, and the rigor cycle. The project, as a research environment, is underpinned by the 'relevance cycle'. This cycle characterizes the contextual environment and provides the route for DS activities to build and develop the artifacts in a practical context. The knowledge base, characterized by theories, expertise or experience is captured within the 'rigor cycle'. This cycle connects the design activities with the domain's knowledge base. The final 'design cycle' links theory and practice, it iterates between developing the artifact/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 are simply virtual game pieces moving around the screen consuming resources to survive and so engages with the subject at an abstracted level.

2 The Gaming Approach

Theories of games have provided valuable lessons through analogy and abstraction and have been used extensively as a way of articulating emergent learning strategies of adaptation and collaboration in human decision-making (Price and Shaw 1998; Marion 1999). Axelrod and Hamilton (1981), for example, applied game theory to study the evolution of co-operation in 'selfish' individuals while William's (1966) work expanded game theory to analyze human behaviour. Whilst 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 (Livari 2007; Hevner, 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: Tylor 1949; Bloom 1956; Wheeler, 1967; Sheehan 1986; Pinar 2004).

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 of a collection of actions, whether formal or informal, undertaken by a social entity and which is expected to introduce social capital into a social system. This is a necessarily ‘broad’ definition of entrepreneurship and enterprise as characterized by the Scandinavian mode of thought (Bjerk 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. Prisoners’ 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 and Hamilton 1981; Marion 1999; Price and Shaw 1998; Axelrod 2006). From a learning perspective, Prisoner’s Dilemma has proved highly effective in developing an appreciation, 1) that organizational structure might promote Prisoners’ Dilemma situations; 2) that cooperation strategies as opposed to individually-optimal strategies are more successful over multiple transactions, and; 3) notions of ‘implication effect’ and self-defeating behaviour.

From a strategist’s viewpoint it may 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” (Ibid, p 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” (Ibid, p123). 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 and is outlined later.

The potential for Prisoners’ Dilemma to be used to teach collaborative action depends largely on the utility (ie. the nature of reward) and the utility map (that is the level of the reward and value differentiation between selfish and collaborative action). Normally this fixed at the outset of the game and is explicitly known by each player. It was important for this work to depart from these rules in three key ways:

1. Utility must comprise of both financial *and social* value
2. The utility must incorporate uncertainty and so explicit value should be unknown to players
3. 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” (Ibid, p.8). Resilience is considered as dependent upon:

1. Maximised efficiency of resource use - since cities are often characterised by inefficient an energy and resource metabolism,
2. The decoupling of resource use from economic activities (Weisz and 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 the least amount of material and energy investment” (Fischer-Kowalski and Huttler 1998, p.120) — which leads back to our first axis and eventually to;

3. The 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 and Hope 2010).

(Source: Chelleri and Olazabal, 2012)

3 Game Play

In order to replicate the rounds of Prisoners' 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 and 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').

<u>The start</u>

Before play starts, the screen displays the initial business environment or causal texture. 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 'O's). This defines the external environment made up of opportunities (extensive finances, few competitors) and threats (few finances and extensive competitors).

[fig 1]

Once entered into the game, the players' enterprises randomly move around the screen. Energy levels, which start the game at 100%, deplete over time and eventually will reach 0% if not replenished resulting in the death of the enterprise. If the enterprise happens to move over a '+' ('finances') its energy is added to 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 weakness) which influences the following ways that 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 emphasize:

1. *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.
2. *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
3. *Metabolic rate.* This determines how efficiently the enterprise can convert the utility, e.g. finances, into energy - thus replenishing the enterprise more effectively.
4. *Amount of social capital outputted 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**.

<u>Environmental 'shock'</u>

The 'finance' utility is programmed to fade and disappear over time thus 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 plays follow suit!

4 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 the paper is an application of Game Theory and an extension of the Prisoners' Dilemma scenario. ExCoRe is fundamentally a strategic decision making game where survival relies on social co-operation and interaction with neighbors. Nowak and Sigmund (1993), in their experiments on cellular automata have noted upon strategies adopted by players when confronted with choice scenarios. In their simulations, they noticed that after several of rounds (generations) of play, certain forms of strategic choice patterns were emerging - 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 were grouping of defectors, it acted to their detrimental effect. Eventually, after 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 natural and social science associated with stability in complex systems (Marion 1999; Langston 1986; Wolfram 1984).

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

Scenario1: 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 in their management of social capital. If an enterprise decided 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 decided to act selfishly and limit their social capital spend then they might only survive in an environment where finances are plentiful.

[fig 2]

Scenario 2: Fewer finances, one entity outputting social value

Where finances are scarce and each 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.

[fig 3]

Scenario3: Almost zero finances

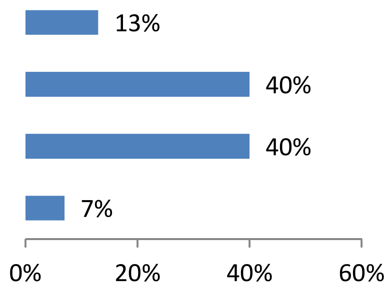
In order to ensure survival the enterprise must rely on consuming the social value trails left behind by others. In the case of complete depletion of resources (financial) then survival is solely based on support from other entities and so a function of reciprocity.

As with the findings of multiple Prisoners' Dilemma rounds above, reciprocity is dependent upon negotiation between players. However uniquely to ExCoRe, the multiplayer environment would mean that this may also occur as a learnt phenomenon through crowd psychology. Players observing others outputting social value trials may consider the benefits creating a snowballing of individual behaviours within the crowd. Significantly this may create opportunities for predators as discussed by Marion (1999) and Nowak and Sigmund (1993). These are defectors who benefit from a collaborative environment without having to contribute to it themselves. However, this may also encourage others to follow suit and again create a 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 co-operation, negotiation, reciprocity, and dependence may ultimately lead to the formation of resilient enterprises, their survival, and most importantly the sustainability of the system of social cooperation they exist within. The compiled choices of strength/weakness allocation for each group over all three scenarios (above) is reported. We see that whilst there is little consensus as to the best strategy for survival in scenarios 1 and 2, scenario 3 overwhelming results in students opting for shared rather than individual-maximizing strategy.

Group 1 Responses:

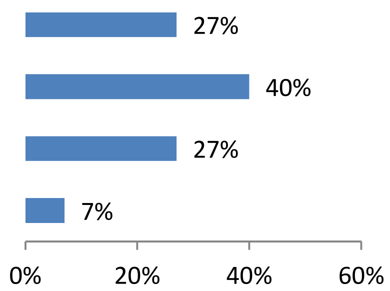
1.) Scenario 1 (Multiple Choice)

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



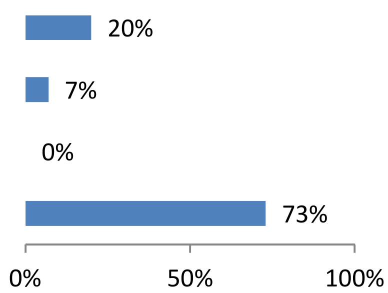
2.) Scenario 2 (Multiple Choice)

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



3.) Scenario 3 (Multiple Choice)

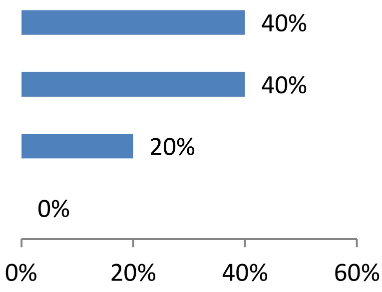
	Responses	
	Percent	**Count**
SPEED	20%	3
COVERAGE	7%	1
METABOLISM	0%	0
SOCIAL VALUE OUTPUT	73%	11
Totals	**100%**	**15**



Group 2 Responses:

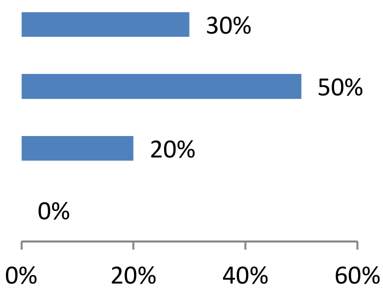
1.) Scenario 1 (Multiple Choice)

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



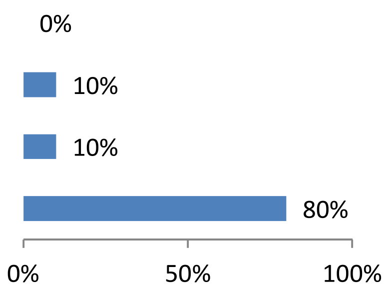
2.) Scenario 2 (Multiple Choice)

	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**



6 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." (Marion 1999, p.51)

This paper started with an objective to help students appreciate resilience of a system (collective) through reciprocity using a prototype virtual environment. The initial prototype is successful in envisaging how entities might interact with the causal texture based upon their profile settings and appears 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 at the system-level. The predominant choices made for scenario 1 compared to that of the lest selfish scenario 3 is illustrated in fig 5

Scenario 1 Scenario 3

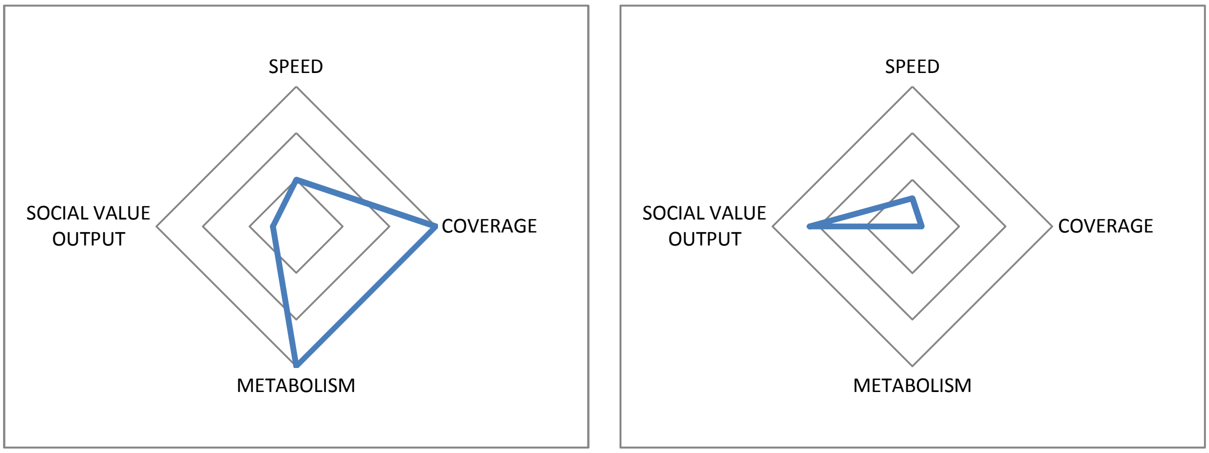


Fig 5: Key shift in allocated strengths and weakness between scenario 1 and scenario 3

Finances are programmed to fade over time and eventually disappear from the game space. As identified in the introduction to this paper, this represents an economic disturbance to which the enterprises internal strengths and weaknesses (fig 5) are reallocated by players in order to adapt. As such resilience and sustainability of the system is maintained, however, this is not through a return to the original state. As Boschma (2014) identifies this is around reconfiguring institutional structures. At a community or systems level, resilience is illustrated to be reliant upon all participants reorganizing, renewing and expressing ability to learn and adapt as suggested by Dale et al (2010).

It is 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 and is a notion 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-dynamic at each conceptual stage. The necessary ontological scrutiny of values and assumptions within this process has provided insight into Prisoners' Dilemma as a teaching and learning tool in the complex environment of community resilience. It is also envisaged that this extension to Prisoners' Dilemma will open new research avenues through gaming into further work on complexity in crowd dynamics and evolutionary learning strategies of individuals and groups within this environment. From a practical perspective the recently introduced Social Value Auditing (SVA) initiative may also benefit from the acknowledgement that a systems rather than enterprise level assessment is necessary to appreciate effectiveness; focusing auditing efforts, research, and pedagogy on resilience through reciprocity.

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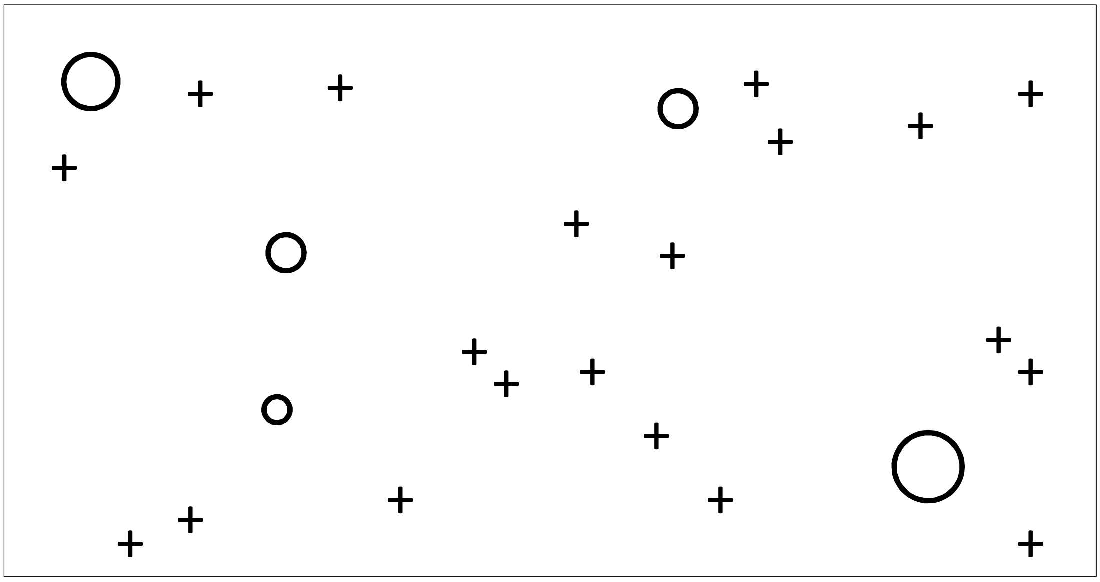
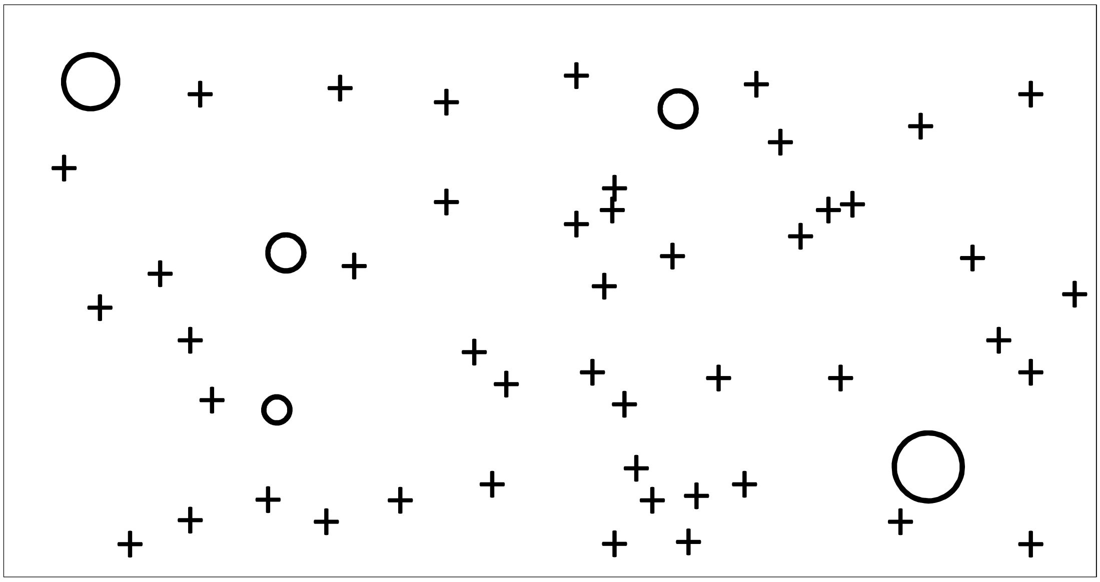
[fig 1]



[Fig2]



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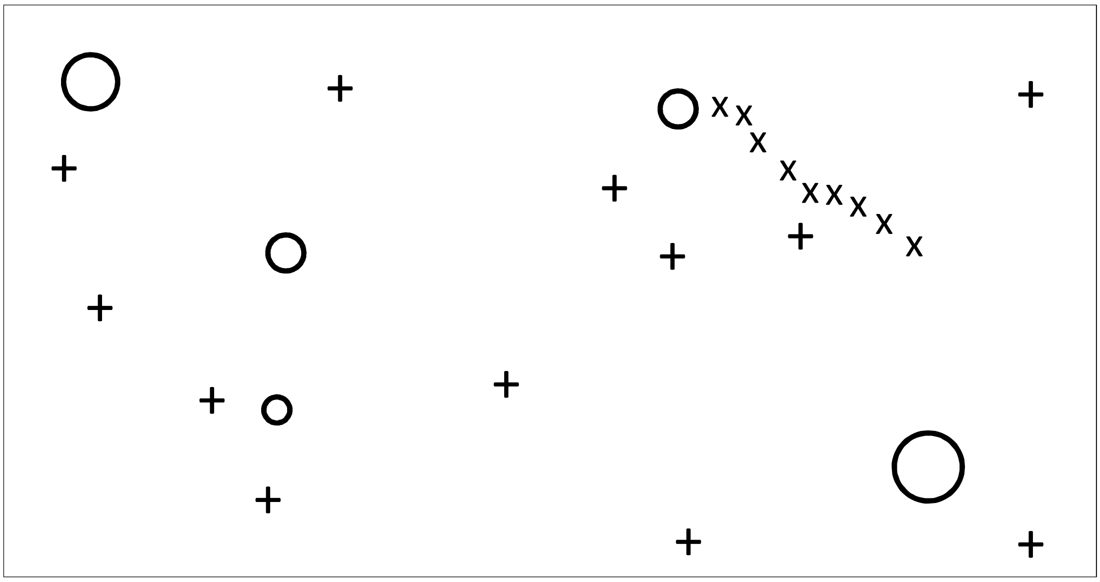

[fig4]