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Collective Intelligence Design and a new Politics of System Change

Hogan, Hall, and Harney

Abstract

While internet technologies may support an emergent 'wisdom of the crowd' and new enhanced forms of political engagement, iterative design of technology is needed to better support our collective intelligence and collective action into the future. Future iterative designs need to include a synthesis of political philosophy, education, and technology design that supports the emergence of a new, higher-order wisdom of the crowd, specifically, a form of team-based system science intelligence that is matched to the complexity of the societal problems we face. Building upon the seminal work of John Warfield, we propose Applied Social Science as a new synthesis is this regard. Warfield argued for a form of applied systems science that incorporates basic science into a technology-supported science of design, complexity, and action, and he developed a specific methodology to support systems level thinking and action planning in problem solving teams. While it is possible to embed Warfield's methodology within the World Wide Web, we argue that this is best achieved in the context of a new approach to collective intelligence design and a new politics of system change that upholds freedom as non-domination as a principle of dialogic engagement in democratic educational and political environments. We also suggest the import of design-based research (DBR) from educational science as a methodological approach to iteratively designing and evaluating infrastructures that support new forms of democratic political engagement on the World Wide Web.

Introduction

The future is uncertain. There is little doubt about that. Throughout history, people all over the world have sought greater certainty in relation to their future – via myth, religion, ideology, science, technology, and utopian visions – but absolute certainty is nowhere to be found. Each new generation discovers uncertainly afresh and advances upon the knowledge of previous generations. How we educate and govern ourselves influences the way we innovate and adapt to an uncertain future. Our hope is that developing collective intelligence in relation to the systems that shape our life together can help us innovate and adapt to the challenges we face. Our hope is that collective intelligence can help us to manage uncertainty. Our hope implies a subjective stance that influences any design vision we might propose.

When we examine our world objectively, the only reasonable conclusion to draw is that the trajectory of human and world systems over the coming decades is uncertain (Gunderson & Holling, 2002). Major questions and challenges in relation to the future of population health and wellbeing and environmental sustainability loom large. Vast sums of money are being invested in efforts to address these questions and challenges. There is continuous uncertainty as we gather evidence from our experience and science and advance knowledge in relation to ongoing cycles of questions and challenges.

Some people are inspired by uncertainty, and utopian visions of the future abound. Some people assume that technological innovations will replace uncertainty and doubt with certainty and confidence in relation to many (or all) major questions and challenges that currently preoccupy humans (Kurzweil, 2005). However, these visions often lack genuine objectivity in their analysis of human and world systems, neglecting for example the challenge of educating people and supporting their capacity to govern themselves.

Universities and major national and international research funding agencies are also investing more and more in multi-disciplinary research. Teams are becoming increasingly popular in culture. However, because the use of teams across diverse organisational contexts is a relatively recent feature of our cultural evolution, the infrastructure to support teams lags behind our newfound enthusiasm for teamwork. For example, more work is needed to evolve our teamwork methodologies and we need to train more facilitators who can help teams to work together effectively using these methodologies. We also need to learn from our various experimental efforts in the use of teamwork methodologies, such that we can iteratively evolve new, better methodologies.

The convergence of recent trends in our cultural evolution is having profound effects on the design of new technologies, with many new technologies focused explicitly on collective action dynamics. Many recent innovations – including social media, crowdsourcing, wikis, and so on – have emerged in the context of a broad belief that technology has the potential to enhance the connectivity of people and knowledge and, in the context of the World Wide Web in particular, the wisdom of the crowd. However, the use of team-based collective intelligence design – specifically focused on engaging stakeholders or technology users in the design of bespoke technologies – lags behind the general enthusiasm to develop new technology 'solutions' to aid collective action dynamics. As such, technology 'solutions' may simply reflect the ideas of a single coder, or a small group of coders who have their own unique design vision. Many of these solutions are interesting, and even inspiring in certain respects, and when people think about societal problem solving they may simply co-opt these existing design solutions in the hope that they are suitable for supporting group problem solving activity.

For example, although Facebook was originally designed to facilitate friends connecting with one another – sharing, commenting, and 'liking' - with no design vision regarding collective intelligence, governance or societal problem solving, governments have nevertheless become very enthusiastic about Facebook and other social media platforms. However, given their current design, it's unsurprising that social media is predominately used as a one-way information channel, specifically, to share information with the public (Mossberger, Wu, & Crawford, 2013; Campbell, Lambright, & Wells, 2014). In this context, government organizations do not engage the collective intelligence of citizens in any way, using any specific methodology. Of course, when smaller groups are involved, citizens may engage with local governments on Facebook, especially when public administrators promote posts by citizens (Bonson, Royo, & Ratkai, 2015).

Also, while it may be possible for governments to use social media as a way of crowdsourcing citizen input relevant for policy development work, there is a recent trend to develop 'passive' crowdsourcing methodologies. These passive crowdsourcing methodologies do not involve dialogue between government and citizens per se, but rather algorithm-driven analysis by technologists of the language, arguments, and sentiments of citizens on social media, with a summary of this data handed to public administrators (Charalabidis, Loukis & Androutsopoulou, 2014). Public administrators have a choice at this point to engage in active dialogue with citizens, but there is no guarantee that they will. It is unclear what effect these types of ‘passive’ interactions will have on citizen engagement and team dynamics, particularly if a broader societal aim (e.g., as recommended by the United Nations) is to support enhanced participatory governance and collaboration between citizens and public administrators in the future.

Of course, there are many useful technologies and methodologies that can be used in a broadly participatory model, including e-voting, online opinion polling, online town hall meetings, citizens' discussion groups, and active use of social media by citizens (Andersen, Henriksen, Secher & Medaglia, 2007). Collaborating teams of citizens and public administrators may also welcome the use of algorithms designed to summarize or coordinate their active inputs, particularly if the algorithms they are using are transparent and enhance effective and legitimate governance. The challenge is to specify and implement collective intelligence designs that are agreeable to citizens. This is more challenging that blindly taking a technology solution ‘off the shelf’. As such, in charting an adaptive course of action into the future, it is valuable to slow down, think about the problem situation we face. At this unique point in human history, it is important to reflect upon ways in which we can best support our collective intelligence and collective action into the future.

The unfolding of history

Charting an adaptive course of action into the future has always been a challenge for human beings. A little history reminds us where we’ve come from (Gombrich, 2005). The study of history prompts a deeper analysis of the current state of human and world systems. We can study our past and the intelligence behind our various past activities -- the mass migrations, innovations, partnerships, conflicts, feats of engineering, and ideas and designs that have shaped our world. We can attempt to reverse engineer the intelligence involved, and the influences shaping our past activities. We can seek to understand the problems – or problematic situation – that our ancestors were seeking to resolve with their actions (Foucault, 1972). This is a very useful learning exercise for us, as we have the capacity to learn from a deep analysis and understanding of our past experience.

Of course, analysing and reflecting on our history and past experience can be time consuming, much like the forward-looking design work and hypothesis testing of science and technology innovation. It’s all hard work. Similarly, learning how to educate and govern ourselves involves reflecting on the history of education and politics, and projecting far into the future, as far as we possibly can, in our ongoing design and hypothesis testing efforts. This can be tiresome work. Thus, we sometimes close down our more refined, reflective intellectual operations, particularly in a problematic situation where we sense some immediate urgency to act, or some impending crisis that requires our immediate attention (Kahneman, 2011).

Consider the stress and sense of crisis that our state of health and wellbeing can provoke, and the associated challenge of supporting our population health. Understandably, an impending health crisis captures our attention and provokes an immediate urgency to act. If our loved one suffers a head injury, we race to the hospital at top speed. At the same time, we often fail to act until a crisis arises and this is reflected in a major imbalance of perspective in the way we care for ourselves: we overrate the value of healthcare focused on proximal biological factors and we devalue preventative healthcare (James, 2016). Currently, 95 – 96% of healthcare spending in the UK and U.S is on biomedical treatments, with only 4 – 5% of budgets available for preventative healthcare. We get a very poor return on investment in this regard. For example, analysis of the reduction in death rate from coronary heart disease in the last decades of the 20^{th} century indicates that risk factor reduction had a twofold greater life-saving effect than biomedical intervention. Unfortunately, our collective approach to healthcare does not reflect a passion for prevention. We often fail to analyse the historical data and reflect upon the system of influences at play.

We need to understand that politics and education are intimately linked, in the sense that our political infrastructure should ideally support a form of education that allows for the development of our individual and collective intelligence and knowledge, which in turn upholds the integrity of our political decision making at a population level. We need to cultivate a capacity for deeper reflection and understanding of the past and current state of human and world systems, and a capacity for more effective deliberation, planning, organisation, hypothesis testing, and collective action into the future. The future will always remain uncertain, but the present state of the system as it unfolds over time is open to redesign. We propose Applied Social Science and Collective Intelligence Design as a political, educational, scientific, and methodological infrastructure to support our ongoing design work.

Applied Social Science

Applied Social Science is an approach to group problem solving where all group members are free from domination by other members of the group. If individual group members are not free from domination, if they cannot communicate their knowledge and reasoning -- squarely, non-reactively, and non-submissively looking one another in the eye – and contribute to the collective intelligence of the group, then they cannot co-lead the collective intelligence and collective action of the group. As such, while basic social science might shy away from claiming that it adopts a particular political philosophy, Applied Social Science adopts a distinctive republican political philosophy, that is, the original form of republican political philosophy, which is founded upon a simple principle – the principle of freedom as non-domination (Pettit, 2014).

The principle of freedom as non-domination implies collective empowerment, equality, and a shared, normative social justice that upholds the status of every member of the group as a leader amongst co-leaders. Naturally, it may take teachers and students time to understand, negotiate, and apply the skills associated with the practice of this principle of freedom as non-domination in an educational context, but this process of skill development is essential for our broader societal development, if our goal is to catalyse collective intelligence and work together in team configurations to iteratively design and redesign our future together.

The design of education is central to the overall design of society. As argued by Habermas, Dewey, Stein and many other scholars, the governance structure conducive to an education-centric society needs up uphold some form of *deliberative democracy*, where, as Zachary

Stein puts it, individuals offer their voice, not just their vote. As such, we need to institutionalize processes for consensus-making through structured dialogue and deliberative engagement. As noted by Stein (2017), this form of governance is a necessary condition for the type of educational abundance that supports the realization of human potential. Stein reminds us:

"John Dewey always used to argue that true democracy is intrinsically educational because it is a process that seeks a continued opening into new experience and learning. Our current democracies are at their best when they sparked reasonable and reflective discourse, beyond the spectatorship and sports-fan-like jeering, where people come together with a feeling that their words matter and they have the power to decide what is best for their lives and communities." (p. 169)

But Stein, along with Dewey and Habermas and many other astute observers of society, points to a broader problem, a problem that is intimately related to our educational infrastructure design. Simply put, most modern democracies are not very democratic and many societies have little or no democratic infrastructure. Stein argues the case forcefully as follows:

"Many democracies around the world, but especially the United States, have largely devolved into dysfunctional oligarchies. Public participation has regressed into the viewing of carefully crafted political spectacles, which are followed by voting, a process akin to watching advertising and then going out to make a purchase. And, of course, there are still millions living in societies that are radically nondemocratic and openly opposed to the principles of democratic governance. These regimes range from totalitarian dictatorships to fundamentalist theocracies, creating geo-political pockets of unspeakable suffering and appalling ignorance." (p. 168)

Stein reminds us of the more progressive educational visions of our distant past – and how we might, into the future, distinguish ourselves as a community that supports an alternative *paideia*:

"Paideia is a Greek word with wide ranging connotations, referring broadly to the raising of younger members of society in the context of a *polity*, or political community. The creation of the collective *paideia* was believed to transcend and include the creation of the *polity*. A well-functioning *paideia* is a community drawn together by subscription to an explicit philosophy of the good life and a related praxis of education, a community that is focused on the creation of a certain kind of virtuous human, a community in which economics and politics are subordinate to an explicitly educational vision. This is a vision of society in which life itself is understood as a process of deliberate cultural and ethical aspiration, across generations. According to this way of thinking, when new forms of social life are created, when new *polities* are founded, when revolutions are undertaken and sustained, they require more than legislating new laws or transferring property and sovereignty. Remaking society requires remaking *education*—instituting a new vision of the *paideia*. Groups can be thus understood to distinguish themselves by establishing alternate modes of education, each mode playing a role in shaping the future through the creation of a new kind of human." (p. 5)

This view is consistent with the fundamental design orientation of Applied Social Science. While traditional forms of collectivism have often maintained a rigid status quo and untenable rules regarding the distribution of goods, services and knowledge, the new collective needs to be different. The new collective needs to focus on design work, and avoid simply accepting the design solutions already provided – and we need to be free to exercise our collective intelligence in this ongoing design process.

Collective intelligence design foundations: freedom, education, methods, and teams

Facilitating collective intelligence is challenging. There are many layers to this challenge. We can begin by highlighting the importance of *freedom*, *education*, and the application of *methods* by *teams*. As noted, freedom and education are fundamental in supporting any emergent collective intelligence at a societal level. Furthermore, the application of methods in a team context is fundamental to collective intelligence. Teams are the most cohesive, interactive, highest functioning groups we can design (Forsyth, 2014). Thus, it is valuable to teach students how to work in a team. However, in doing so, we need to teach students methodological skills such that they can maximize their collective intelligence and complete project work as a team. We argue that skill in the use of team-based collective intelligence methods can be acquired within an educational environment and can be used to support learning throughout life. Building upon the work of John Warfield, we argue that the synthesis of Warfield's collective intelligence methods with other social science and systems science methods is important for the evolution of Applied Social Science. Ultimately, Applied Social Science is strongly focused on the team-based application of methods that can be used to solve problems in real-world contexts, in collaboration with the stakeholders in the problematic situation. Applied Social Science builds upon the Applied Systems Science model that Warfield developed.

John Warfield and Applied Systems Science

Throughout his career, Warfield worked to develop a vision for an applied systems science. At a high level of abstraction, Warfield described a very unique systems science framework. Specifically, he argued that systems science is best seen as a science that consists of five nested sub-sciences, which he arranged compactly using the notation of set theory (Warfield, 2006). Consider the following, says Warfield:

Let **A** represent a science of description. Let **B** represent a science of design. Let **C** represent a science of complexity. Let **D** represent a science of action (praxiology). Let **E** represent systems science. Then

$$\mathbf{A} \subset \mathbf{B} \subset \mathbf{C} \subset \mathbf{D} \subset \mathbf{E} \qquad (1)$$

Warfield's basic idea is relatively easy to understand when we break it down. What he suggests is that we can learn something of systems science by first learning a science of description (e.g., physics, chemistry, biology, psychology, sociology, economics). What we learn when we study a specific discipline is the knowledge that has accumulated over time in that discipline, and we also learn about methods used to acquire knowledge and address problems relevant to that discipline. As such, we often begin my learning a *biased* science, says Warfield – biased in the sense that our knowledge and methodological skill is discipline specific.

But we can build upon, and coordinate the knowledge and skill across the domain-specific or *biased* sciences, says Warfield: we can learn a science of design that includes a science of description. The science of design is fundamental if our goal is to design new systems, or redesign existing systems (e.g., redesigning a school system in collaboration with stakeholders and key experts, importing relevant knowledge from disciplines such as psychology, group dynamics, sociology, economics, etc.). In Warfield's view, the science of design implies the use of team-based collective intelligence methods that allow us to build structural models that help us to understand specific problems we face, and solutions that help us to address those problems.

At the same time, the science of description and the science of design need to be embedded within a science of complexity, says Warfield. The complexity and subtlety of our solutions and actions in response to any problematic situation is a function of the complexity and subtlety of our understanding of the problematic situation. Therefore, a science of complexity is needed if our goal is to integrate a large body of diverse knowledge that different stakeholders consider relevant to the problematic situation. When we combine many elements (e.g., many ideas and relations between ideas) and try to coordinate them in a system of understanding, we face the challenge of complexity in our design work. Importantly, says Warfield, we need to understand how to manage complexity and avoid cognitive overload and confusion as we work together as a team.

Finally, says Warfield, we can learn a science of action that includes a science of description, a science of design, and a science of complexity. The science of action is fundamental if our goal is to catalyze collective action for the purpose of bringing about system changes that are grounded in the sciences of description, design, and complexity. The science of action focuses on the coordinated activity of a group of people in context, as they work to understand and respond to the problematic situations they face. In Warfield's view, all of these sciences need to be included as sub-sciences in the broader field of systems science, particularly if systems science is to have any applied impact in shaping coordinated group design efforts in context.

Warfield's vision for systems science implies a vision for education. For example, if University students are to learn a form of applied systems science that helps them to work with others to resolve societal problems, they need to learn how the domain-based science of description that is their primary focus of enquiry at University (e.g., psychology) can be integrated with other domains of enquiry (e.g., physics, chemistry, biology, group dynamics, sociology, economics) in the context of a broader science of design, complexity, and action.

In an educational context, this implies an approach to teaching and learning that is not commonly practiced, specifically, a collaborative approach grounded in dialogue and the exchange and coordination of knowledge and skill in a team. Also, beyond simpler forms of collaboration (e.g., unstructured dialogue in a group setting) Warfield's methodological vision implies that we have access to methods that allow for integration across the sciences, specifically, the construction of structural models that synthesise the knowledge of a team.

Notably, Warfield's vision for applied systems science is instantiated in part in the systems science methodology he developed, Interactive Management (IM). IM includes a set of methods and tools and a facilitated thought and action mapping process that helps groups to develop outcomes that integrate contributions from individuals with diverse views, backgrounds, and perspectives.

Warfield argued that the tools of systems science will be most effective if they integrate our capacity to share meaning using *words*, represent causality using *graphics*, and model complexity using *mathematics* (see Figure 1). IM integrates all three of these components in its design. Warfield also highlights the distinction between the mathematics of content and the mathematics of logic and structure. To support groups in developing structural models that capture the complexity of interdependencies between problems in a problematic situation, Warfield leveraged the mathematics of logic and structure, drawing in particular on synergies between formal logic, matrices and graph theory in a way that allowed the logic of group members, as represented in a matrix of decisions, to be represented visually in a graph.

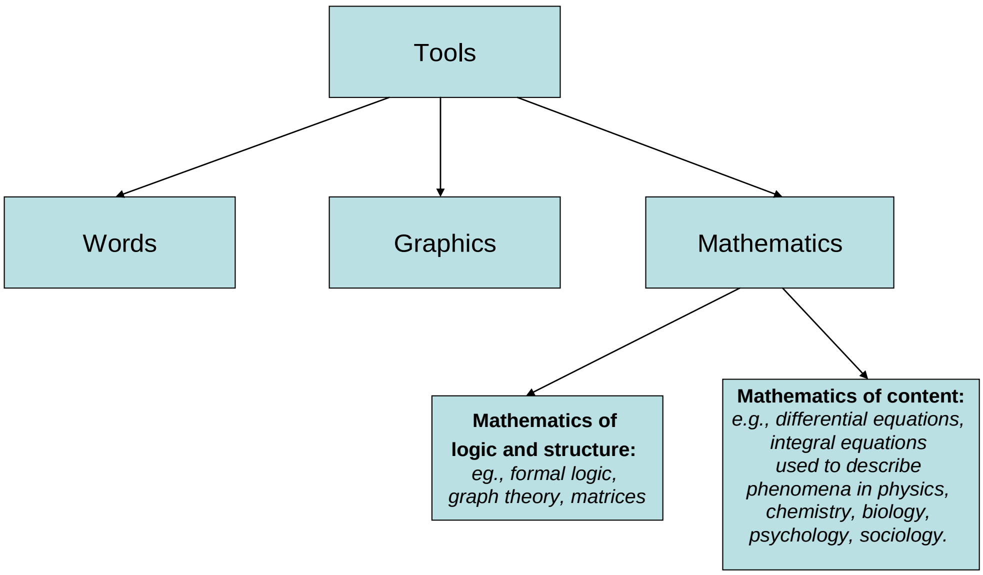

Figure 1. Systems science tools needs to work with our capacity to share meaning using words, represent causality using graphics, and model complexity using mathematics.

Collective intelligence teams - enabling, exploring, implementing, and managing

Warfield (1976) notes that when (1) a *team* of people come together to focus on (2) a complex *issue,* they need (3) a *methodology* that helps them achieve an adequate synthesis of knowledge and perspectives that supports collective understanding and action in response to the issue. Warfield highlighted the need to partition the team into three sub-groups (ibid p. 27 – 28):

- Stakeholders – the people who have a stake in the issue being considered.
- Content specialists – the people who have specialized knowledge that is relevant to an issue under consideration.
- Structural modelers – the people whose task it is to structure the issue being considered.

While stakeholders and content specialists communicate the knowledge essential for understanding the issue or problem the team is addressing, the structural modelers facilitate the team in structuring their knowledge using specific facilitation strategies and tools. In particular, focusing on the three key components – words, graphics, and mathematics – Warfield developed a methodology and associated toolkit that allowed groups to develop graphical structural models that mapped out logical relationships between ideas: relationships that provided the team with insight into the structure of a complex issue they face. The specific tool and methodology Warfield created for developing structural models he called *Interpretative Structural Modeling*, and this methodology was one from a set of methodologies he used to help teams explore complex issues, generate and structure ideas and work together to resolve shared societal problems. Because a team of people were interacting to collectively design and manage their response to a complex issue, Warfield called his new approach to societal problem solving, *Interactive Management (IM)*.

The IM methodology includes a number of basic steps:

1. First, a group of key stakeholders with an interest in resolving a problematic situation comes together in a situation room and are asked to generate a set of 'raw' ideas (commonly 50 – 200) about what might potentially have a bearing on the problem. Group discussion and voting helps the group to clarify the sub-set of ideas that bear upon the most critical problem issues (see step 1 & 2 in Figure 2).

2. Next, using IM software, each of the critical issues are compared systematically in pairs and the same question is asked of each in turn (e.g., "Does A influence B?"). Unless there is majority consensus that one issue impacts upon another, the relation does not appear in the final analysis.

3. After all the critical issues have been compared in this way, IM software generates a graphical problem structure (or problematique) showing how the issues are interrelated. The problematique can be viewed and printed for discussion (see step 4 in Figure 2).

4. The problematique becomes the launch pad for planning solutions to problems within the problem field. The logical structure of problems is visible in the problematique and when generating solutions, action plans are aimed at resolving problems in a logical and orderly manner.

5. When the group is happy that they have modeled both the problem field and the best possible set of solutions, the IM session closes and each member leaves with a detailed action plan, a specific set of goals to work on, and the roadmap and logic describing how all the various plans and goals of each member will work together to resolve the original problem.

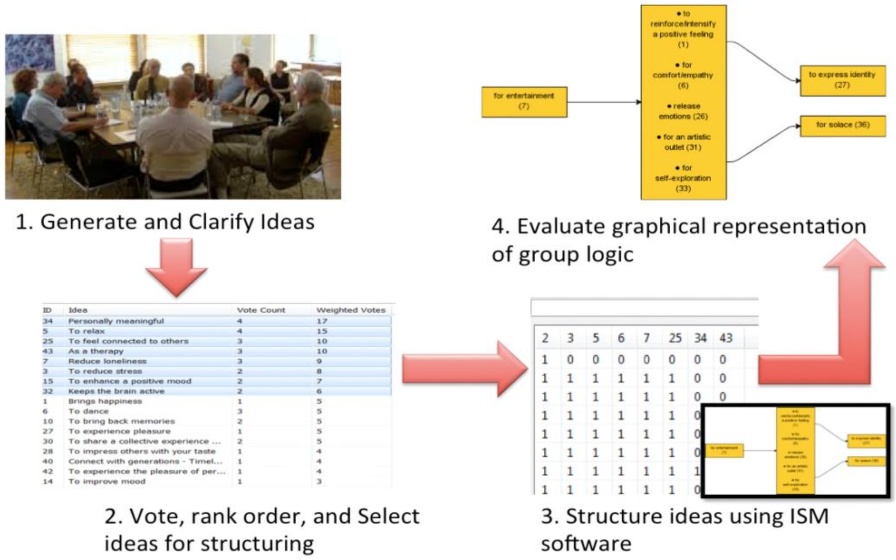

Figure 2. A simple visual description of some of the key steps in the IM methodology

IM has been applied in many different situations to accomplish many different goals, including assisting city councils in making budget cuts (Coke & Moore, 1981), developing instructional units (Sato, 1979), designing a national agenda for pediatric nursing (Feeg, 1988), creating computer-based information systems for organizations (Keever, 1989), improving the U.S. Department of Defense's acquisition process (Alberts, 1992), promoting world peace (Christakis, 1987), improving Tribal governance process in Native American communities (Broome, 1995a, 1995b; Broome & Christakis, 1988; Broome & Cromer, 1991), developing a national wellbeing measurement framework (Hogan et al., 2015), understanding the key dispositions of good critical thinkers (Dwyer et al., 2014), and training facilitators (Broome & Fulbright, 1995). The IM method has also been combined with other computer supported learning methods, including argument mapping methods (e.g., in an educational training context, Hogan et al., 2014). The method has also been combined with other design methods, including scenario based design, in a variety of technology innovation projects (Long et al., 2017; Hogan et al., 2017).

Notably, the IM methodology can be used with a variety of different idea types, which can be structured using a variety of different relational statements. For example, IM can be used to structure problems, objectives, options, and so on, using a variety of different relational statements (e.g., *aggravates, enhances, promotes, supports*, etc.). In can also be used in a variety of different environments (e.g., in workshops, classrooms, at conferences, etc.). For example, moving beyond the traditional style of academic conference work, we have use IM in a conference setting to structure barriers to wellbeing in Ireland (Hogan & Broome, 2012) and to structure objectives that we need to pursue to tackle those barriers (Hogan & Broome, 2013).

Given his societal focus, Warfield also recognised that a larger collection of people, other than a core problem solving and planning team, play a significant role in our ability to collectively resolve societal problems. A number of other groups are instrumental in enabling, implementing, and managing the processes essential for complex issue exploration and successful societal problem solving. Warfield describes three functions in particular – the enabling, implementing, and managing functions - each combining three unique elements and each including people outside of the core problem solving team (see figure 3).

- The *enabling* function, says Warfield, is critical for any team to proceed: it involves (1) a *sponsor* who controls (2) *funds*, and who has sufficient interest in (3) the *ideas* related to an issue. There is always a cost associated with teamwork and intensive collective intelligence work and a sponsor needs to provide funds to enable any such exploration to proceed.
- The *implementing* function, says Warfield, involves coordination between (1) the *stakeholders* in the issue that was explored and (2) the *doers* who decide to act and carry out the proposed actions based on (3) the *results* of exploration.
- Finally, the *managing* function involves (1) *leadership* in identifying issues to focus on and (2) *planning* and designing a scenario for the future through (3) "…*brokerage* among the sovereign entities involved, including the sponsor, the team, the stakeholders, and the doers, plans that incorporate the results of exploration of the issues are translated into results in society" (1976: p. 34).

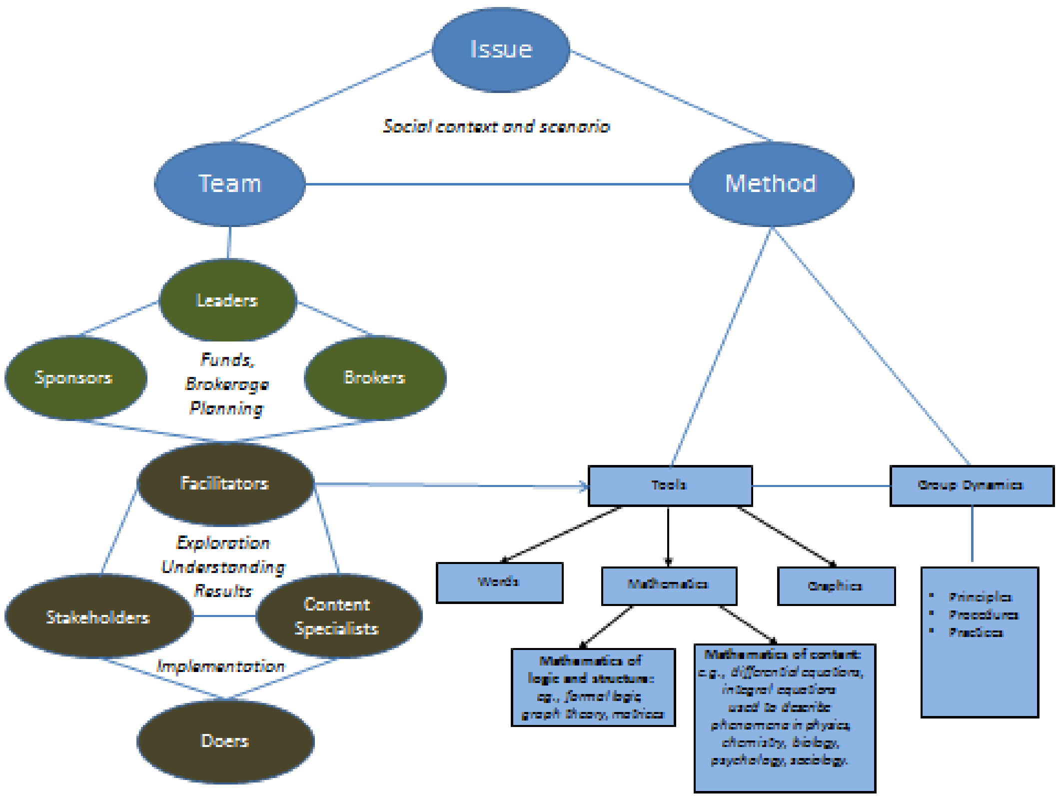

Figure 3. Coordinating teams to resolve societal problems using tool-supported methods.

In summary, Warfield argues that solving societal problems involves the synergistic sum total of 12 elements, some of which are abundant (sponsors, ideas, funds, issues, stakeholders, doers, planning), and some of which are in short supply (teams, methodology, leadership, brokerage, and results). Warfield's approach to teamwork and societal problem solving can be described as a form of *applied systems science* – a systems-based understanding of a complex issues is developed, along with an action plan, by a team of stakeholders, content specialists, and structural modelers; and this group works closely with a network of other key players – leaders, sponsors, brokers, doers. Given the 12 elements involved, and the level of collective action and coordination needed to get started, it is unsurprising why we see limited teamwork and often poor team performance in relation to societal problems. As Warfield notes, teams, methodology, leadership, brokerage, and results and in short supply. Building upon Warfield's vision, central to the challenge of Applied Social Science is building the capacity of teams in the use of methodologies that support their collective intelligence and collective action, providing opportunities for learning and skill development, and reinforcing an education-centric political infrastructure that upholds freedom as non-domination and the quality dialogue and deliberation that is needed to sustain creative exchanges amongst group members.

Societal problem solving is a political process

Given the actors involved, and the focus on societal issues, the process of societal problem solving that John Warfield describes is clearly political in nature. At the same time, given his grounding in systems science and the fact, as Warfield emphasised, that societal problem solving involves the import of scientific knowledge (i.e., working with content specialists from various domains of science), the process he describes is also scientific in nature. Indeed, it is a process that requires a synthesis of science and politics. As such, it requires some understanding of political and scientific enquiry as they are normally practiced, and some effort to synthesise the two approaches to enquiry.

Historically, scientific enquiry and political enquiry differ in certain respects. Central to scientific enquiry is the goal of discovering and organising knowledge. According to Warfield (1976), three forms of scientific knowledge are of special relevance to societal problems. These are descriptions, frameworks, and algorithms. As noted by Warfield:

"Descriptions are viewed as recounts of what happened in a situation. They differ from frameworks and algorithms in that they do not recommend or prescribe human behaviour. Much of social science is descriptive. Frameworks represent gross prescriptions for behaviour. They can be very broad, as in the Marxian framework for economic behaviour, and also very open to varied interpretations, as in the "systems approach". Algorithms represent specific prescriptions for behaviour, down to the level of the "unit act"… In general, the linkages between descriptions, frameworks, and algorithms are obscure or absent. It is almost as though those who like to describe have no passion for prescribing behaviour, those who like to prescribe behaviour in the large have no concern for the practical necessities of knowing how to carry out such behaviour, and those who like to prescribe behaviour in the small are insensitive to the larger ramifications of such behaviour… descriptions, frameworks, and algorithms are independently available in large supply. But what is usually needed is some proper combination of these three types of knowledge in a mutually compatible synthesis" (p. 46 - 47).

As such, while a key goal of science is discovering and organizing knowledge, science doesn't necessarily proceed in a fashion suitable for ready import into societal problem solving -- descriptions, frameworks, and algorithms do not arrive in a ready-made synthesis suitable for understanding and resolving specific, local societal problems.

Traditionally, political enquiry fills the gap by prioritizing as its primary goal "the construction of sound policy and the creation of decision-making structures that facilitate the making of effective decisions" (ibid. p. 47). Political enquiry is generally very different from scientific enquiry – discussion and debate are the primary methods of communication and learning; the enquiry tends to involve oral communication that is often spontaneous, unpredictable and disorganized. Scientific enquiry, by contrast, tends to involve written communications in scientific journals, and the process of enquiry tends to be more organized, predictable, and deliberate. Scientists less often meet to debate and more often meet for conferences where they take turns speaking alone for long periods of time. Organised science within universities may reinforce the individual pursuit of personal goals by scientists rather than a team-based focus on societal problems.

Warfield notes that while scientific goals and political goals are different, there is a common *need* fundamental to both – the need to learn – and the question is whether or not the processes of science and scientific enquiry can contribute to the learning that results from political enquiry and political debate. Warfield recognised that our cultural evolution has entailed an increase in societal structural complexity, specifically, in the level of knowledge, occupational and technical specialization within the population and the overall division of labour within societies. Although division of labour is necessary for complex societies that seek solidarity in their efforts to survive as functional entities, much like Durkheim proposed, the problem, according to Warfield, is that more division of labour within our society implies more challenge and more complexity in the task of communicating across the full scope of societal issues. Given our evolved, limited cognitive capacities, Warfield suggests that the quality of political debates deteriorates rapidly as the complexity of our society increases. The benefits of dialectic exchange and debate rapidly deteriorate. This has implications for citizens and public administrators who seek to use debate to facilitate the construction of sound policy.

As Warfield puts it, "as societal issues have become increasingly complex, the quality of political debate has deteriorated, and the citizen cannot rely on such debate as a means of becoming an informed participant in political decision making"(ibid., p. 48). At the same time, we cannot hand over decision-making to machines, computers, or algorithms -- societal problems need to be addressed through some process of public debate and discussion, and thus it is important to consider how processes of science can contribute to the learning that results from such debate. In Warfield's view, the 'machine' need not take over control of the process; rather, the machine can support debate and deliberation, by expanding the bounds of our 'bounded rationality', for example, by presenting information for debate and consideration in small, manageable chunks, by highlighting important relations among pieces of information, by imputing the logic of team members derived from debate into mathematical equations that build toward a larger, more complex synthesis, by portraying the synthesis of this logic back to the group for the purpose of reflection, and so on. Ultimately, as noted by Warfield (ibid, p. 51):

"The machine can construct and display the nature of a complex inference structure before a full audience, whereupon the display itself plays a major role in the debate. It can be thought of as part of an art form, which is judged by some of the standards by which art is judged. Does it communicate? Is it meaningful to the viewer? If flawed, can it be improved by further attention from the artist?"

Although Warfield developed a very rigorous computer-supported collective intelligence process, he cautions that the “burden of quality still lies with the artists”. In other words, the quality of our collective intelligence always, fundamentally, rests on the quality of our dialogue and deliberation. Facilitating collective intelligence, no matter what way we look at it, involves facilitating the intelligence of people -- people who come together to work as part of a team.

Applied Systems Science and the future design of Education

In general, the integration of team-based systems science methodologies into the school and university curriculum is still poorly developed, and this reflects a more general tendency to limit the amount of time for collaborative work in school and university environments. Also, while it is reasonably easy to build a structural systems model if one has access to relevant tools, cultivating the critical thinking skills necessary for the analysis and evaluation of scientific evidence embedded in structural models can take time, and it can also take time to cultivate domain-specific systems level thinking in students at school level prior to their entering university (Hogan, Harney & Broome, 2015; Stein, Dawson & Fischer, 2010). Warfield did not focus directly on these challenges. Also, while Warfield was critical of mathematical models of systems that include no words to carry meaning, he did not seek to integrate his team-based matrix structuring method with other mathematical methods that allow, for example, computation of statistical fit indices (e.g., using structural equation modelling, SEM) or deeper understanding of system relationships and system dynamics (SysD) using mathematical modeling tools (Maani & Cavana, 2000). Furthermore, Warfield was less familiar with research in the fields of psychology, education, group dynamics, and communication, all of which are relevant to understanding the way teams behave in a learning environment, and outside of a dedicated learning environment. These and other considerations suggested a need to expand Warfield’s vision.

In an effort to disseminate and expand Warfield’s vision, we presented a simple model to scholars in the field of education. We suggested that teachers consider coordinating the 3Ts in their teaching of applied systems science: *Tools, Teams* and *Talents* (see Figure 4).

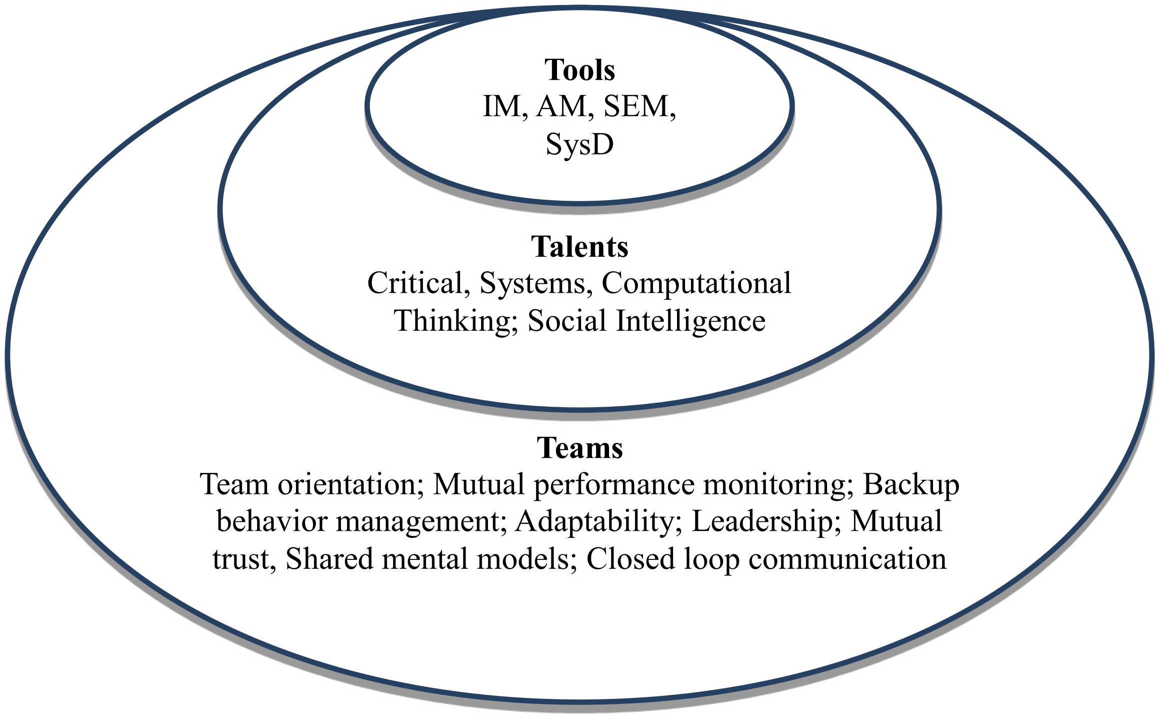

Figure 4. Three levels in a framework for systems science education -- Tools, Talents and Teams. Note: IM = Interactive Management, AM = Argument Mapping, SEM = Structural Equation Modelling, SysD = System Dynamics.

We argued that developments across these three levels are mutually supportive. For example, training in the use of tools can facilitate the development of individual talents (e.g. training in the use of an Interactive Management (IM) matrix structuring tool can support the development of systems thinking; the use of argument mapping (AM) tools can support the development of critical thinking skill) while also promoting effective team dynamics (e.g., if IM and AM tools are used collaboratively by a group). Efforts to promote effective team dynamics may also accelerate the development of individual talents and the development of tool use skills. Similarly, cultivation of individual talents may support more effective use of tools and more effective team dynamics.

We also argued that systems science education should not be limited to the classroom: individual talents and effective team dynamics develop more fully when applied systems science education extends to real-world social situations and real-world problems. This was central to Warfield's vision. Indeed, Warfield developed IM primarily for application in real-world settings where groups were dealing with real societal problems. Certainly, if a curriculum focused on applied systems science as envisioned by Warfield is to have any power and potential students need to feel connected to the world and they need to be given opportunities to work with community stakeholders on real world problems.

More generally, we now view systems science education as part of a broader framework we call Applied Social Science. Applied Social Science calls for a new politics of system change that emphasises freedom as non-domination as an intersubjective norm shaping a dialogic approach to education, and the application and development of collective intelligence design as a central pillar of a new education-centric society.

Freedom and Dialogue

While many people define freedom as the *absence of interference* – we are left alone to do as we please – Pettit (2014) proposes a much more subtle and reflective and relational model of freedom. Pettit argues that, in their basic life choices free persons should not be subject to the *power* of others – they should not be subject to a power of interference on the part of others; they should not be dominated by others. Politics isn't about leaving people alone – it's about working with people to make collective decisions. But when we work with other people, we should not work to dominate them. This principle of *freedom as non-domination* provides a simple, unifying standard for evaluating social and democratic progress, says Pettit. It also provides a basis for progressively redesigning our approach to political decision-making, and for analysing the political decisions we make. As noted by Pettit, freedom as non-domination*,* an ideal that was central to the Roman Republic, implies a free citizenry who enjoy equal status with one another, being individually protected by the law that they together control. It is a powerful principle with implications for social, political, and international justice. It is also a principle upon which to build an approach to applied social science that upholds social, political, and international justice.

Freedom as non-domination is a principle that implies a specific approach to the practice of communication, meaning-making, and problem solving in a group. As everyone in the group is empowered, and explicitly works to uphold the power of everyone else, their communication and interaction reflects this principle in a dynamic practice of engagement. Indeed, outside of the specific rules, infrastructures, technologies, and artefacts of culture that we may design specifically with freedom as non-domination in mind, our everyday communication and interaction are the primary means through which we exercise our collective freedom as non-domination. Communication in this context manifests in the form of a dialogue where everyone is equally empowered, not a series of monologues where people hold on to some modicum of power for a time before another person 'takes to the stage'. Indeed, in the monological tradition to communication and 'group learning', some people may never even make it onto the stage. Genuine group learning requires that everyone is involved – everyone is on stage, much like a choir performing in unison. Unlike the long monologues of the scholars at academic conferences, and unlike the long, berating monologue of the teacher in the classroom followed by an abrupt response to a student who has a question, enacting the principle of freedom as non-domination in a group problem solving session implies a *dialogue*, not a series of frustrated monologues and brief divisive discussions.

The study of dialogue has a long history in psychology, communication, management, education, and philosophy. In his recent essay on dialogue, Broome (2009) reviews the major thought leaders who influenced the study of dialogue. The English word dialogue comes from the Greek word dialogos, and it implies that *meaning* (logos) is prefixed or arises *through* or *across* (dia) the communication at the group level (Broome, 2009). As such, dialogue implies a synthesis of meaning that emerges at the group level, and it implies that the group is somehow unified in this effort. In order to achieve this unity of effort and synthesis of meaning, the group needs to adopt a principled stance and communicate in a way that reflects this principled stance. Naturally, learning how to engage in a dialogue requires some practice and facilitation and it may take some time for a group to develop their dialogue skills. Freedom as non-domination can serve to frame a move from monological to dialogical communication and from self-centered to team-centered activity. This is consistent with a number of theoretical views on dialogue (see Figure 1).

A number of classic models of dialogue are noteworthy in this regard. First and foremost, the practice of dialogue involves a unique way of perceiving other people. As classically described by Buber, there is a move from seeing people as ‘objects' to be persuaded, manipulated, or dominated in some way (i.e., where people are dominated by an *I-It* perception of their relationship with others), to a state of being and perception where people see others as people, much like themselves (i.e., people enter an *I-Thou* relationship with others). As such, there is a move away from self-centeredness and any effort at deception, pretense, and domination, and a move away from communication marked by efforts at persuasion, maneuvers to gain prestige, and power-plays to control others in the exchange. We move instead towards a more genuinely communicative state, marked by genuine listening, honesty, spontaneity, directness, and mutual responsibility. Communication is no longer a competition with one winner, a discussion where only one person emerges as powerful and correct, or a conflict where the victorious vanquish their victims. Instead, communication serves to build the relational power and meaning and dialogic intelligence of the whole group, and everyone in the group. As noted by Broome (2009) this view “gives recognition to the interdependence of self and other, the intersubjectivity of meaning, and the emergent nature of reality.” (p. 2).

Carl Rogers emphasised that the interdependence of dialogic relationships also requires a unique concern for human feelings, human relationships, and human potential. Rogers developed a view consistent with the principle of freedom as non-domination: he emphasised the importance of empathy and careful listening, and cultivating a genuine trust in the wisdom of human beings. As noted by Broome (2009):

“He encouraged stripping away facades and moving away from “oughts,” expectations of others, and attempts to please others. Rogers believed that a space could be opened for dialogue when relationships are characterized by a willingness to listen and to enter into a meaningful relationship with the other, genuineness in sharing feelings and ideas with the other, respect and regard for the other, and empathic understanding, which he viewed as entering the private perceptual world of the other and becoming “at home” in it.” (p. 2).

Building upon the principled stance of Buber and the empathic ground of Rogers, Gadamer noted that it is through language that understanding is built in dialogue. Language and emerging understanding clearly manifest in a dialogue as a living, dynamic process that is open to continual development and change as people continue to engage with one another. People come to a dialogue with unique prior knowledge, understanding and prejudices, and the context within which the group engages with one another is always unique. Prejudice, or the various assumptions and biases of individual group members, comes to be recognized and understood as a feature of communication, which forms the basis for deeper understanding as a *fusion of horizons* develops between members of a group engaged in dialogue. Ultimately, says Gadamer, a “higher universality” (1976) emerges that overcomes the limited horizons of each participant. This is a view consistent with the principled methodological approach to collective intelligence developed by John Warfield, in the sense that, in a structured dialogue, thinking develops from the separate positions of individuals to a synthesis that combines individual views.

This is consistent with the view of Bakhtin, who noted the need to balance any emerging dialogic synthesis and common understanding with the uniqueness of individual perspectives. This implies a certain tension in the fluid, open, dynamic dialogic interaction, where, as Broome (2009) notes: "there is a dynamic interplay of expression and nonexpression, certainty and uncertainty, conventionality and uniqueness, integration and separation…an emergent process in which the interplay of contradictory forces creates a constant state of unrest and instability, while also bringing moments of unity and synthesis." (p. 3). John Warfield's effort to develop a methodology and technology to support collective intelligence was designed to produce more than mere 'moments' of unity and synthesis – it was designed with the specific intention of producing a synthesis that makes concrete key aspects of the group's collective intelligence in the form of graphical and linguistic products that showcase the synthesis of language and logic generated by a group during a structured dialogue.

At the same time, Warfield recognised that the process of developing these enduring, consensus-based products entails a dynamic process which requires careful facilitation of dialogue in the room. Consistent with Böhm's view on dialogue, participants in a collective intelligence session need to be patient with the facilitator and with one another; they need to suspend judgement in relation to their own and others' beliefs and opinions, thus allowing a variety of perspectives to co-exist in tension, without premature attempts to resolve them or achieve a 'quick synthesis' at the expense of a fuller, deeper synthesis. It is the fuller, deeper synthesis and more coherent understanding of a problematic situation that sustains the work of the group into the future.

Consistent with Paulo Freire, it is important to ground our ongoing collective intelligence work at a societal level with a solid foundation of dialogic education – we need to learn very early in life, and throughout our lifelong education, how to engage in dialogue and how to learn through dialogue. We need to learn how to protect the dignity of learners, allowing for exploration of new ideas without fear of humiliation. We need to learn how to affirm others in this dialogic learning process, says Freire, and help to instil hope in the minds of an otherwise oppressed community. Indeed, we remain oppressed to the extent that we inhibit dialogue and collective learning and rely instead on the authority of others and their monological wisdom. As noted by Broome (2009, p. 3), in this view:

"Dialogue is built on *humility* to learn from the other, guided by *trust* between communicators, and pushed forward by *hope* for liberation from oppression."

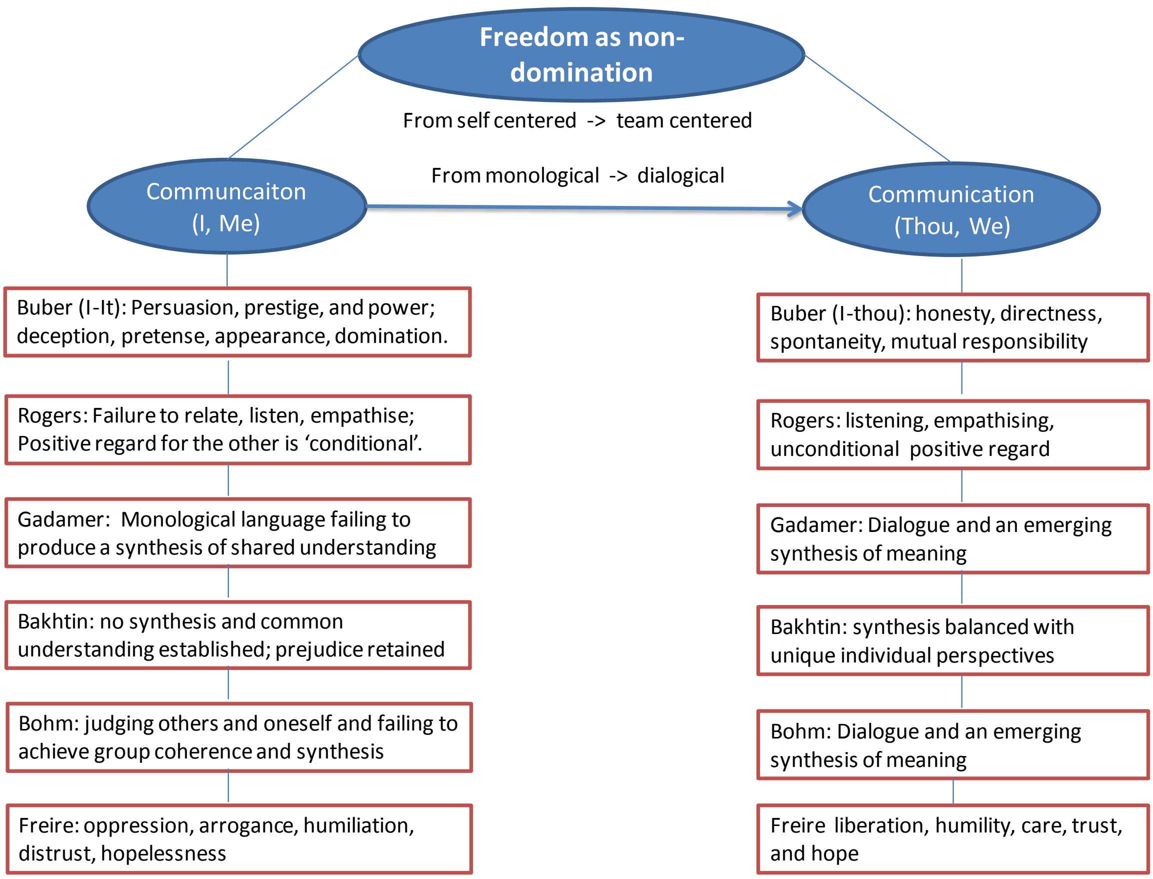

Figure 5. Freedom and Dialogue

Collective intelligence design and the education-centric society

The collective intelligence methods developed by Warfield have been applied in a variety of collective intelligence design projects, and his framework for applied systems science provides a stable view from which to envision a future where education, science, politics, and innovation are grounded in an ongoing collective intelligence design and innovation process. However, the design and innovation process itself implies that the design and application of collective intelligence methodologies will evolve iteratively through cycles of development, including new phases development where Warfield's collective intelligence methods are integrated within the methodological infrastructure of the World Wide Web. This process of development implies the need for ongoing evaluation of collective intelligence design processes and outcomes. In our view, it will be valuable to import the logic of design-based research from the field of education to support this iterative design process into the future.

Educational design research, which can have different methodological variations, including design-based research (DBR), typically entails an iterative, cyclical process of design that accretes and develops over time. The overall aim of educational design research and DBR is to effect real educational change - *in situ* - in learning settings that are intrinsically diverse and distinct, with their own respective constraints, exigencies and possibilities.

Educational design research and DBR are philosophically inspired by Dewey, and his foundational view of the emergent and complex nature of educational change and practice. To adapt Dewey's original idea and words, cited in Hoadley (2005), all sustained and impactful educational change necessarily involves 'intelligent experimentation', which entails that we must attune and nuance our design of educational innovation to meet the particularities and requirements of the diverse learning contexts in which our educational research and development work is situated (Hall et al., 2017).

The goal at the heart of DBR is to be 'intelligently experimental' in how we approach the design and implementation of educational change, especially where innovative, intrinsically complex technology is being integrated and used (Stevens, 2002). Educational design researchers thus endeavour to mobilise educational transformation in both a participatory and principled fashion, that is: involving and working closely with key stakeholders throughout the process, where design changes and decisions are negotiated, agreed upon and implemented in a collaborative fashion, guided and informed by relevant educational concepts, philosophies and theories. In DBR, the key educational stakeholders, e.g. pupils, teachers, parents, policymakers, designers, technologists, etc., engage collectively in the recursive conceptualisation, development and evaluation of educational innovations, situated and refined within learning contexts that are characterised as inherently complex (Brown, 1992; Stevens, 2002; Hoadley, 2005; Barab & Squire, 2004; Sandoval, 2014; Reeves, 2015; Könings & McKenney, 2017).

Normatively, DBR is undertaken over a series of contiguous cycles of design, deployment and evaluation. In our experience, three substantive cycles of design generally work well in terms of piloting, scaling up and sustaining an educational innovation in context (Hall et al., 2017). A typical structure for DBR will firstly involve an initial, pilot design experiment, which is a ground-clearing exercise to scope out and test the potential of an innovation, and whether it merits further development. Once the pilot illustrates its potential, the innovation is scaled up to a mainstream intervention, where a larger number of learners are involved in the participatory design process, and thus its impact is potentially widened. This we term the ground-breaking stage – because it is typically the phase during which most is learnt about the efficacy and potentiality of the innovation, and how it might be implemented and sustained for optimal impact. The third cycle, which we term the capstone intervention, should serve to corroborate the design process overall, and the innovation's summative impact at that point.

In terms of DBR outputs, according to McKenney & Reeves (2012), there are two primary axes of educational impact resulting from systematic educational design research interventions: (1) *proximal* and (2) *distal*.

The proximal impact is the maturing local intervention, augmented and refined as the participatory and principled design process embeds the innovation in context. Secondly, the distal impact is the model or framework of learning that emerges from critical reflection on the emerging innovation in terms of extant, relevant concepts and theories. This critical, reflexive interplay of practice and theory in DBR embodies intelligent experimentation – pushed by practice while pulled by theory - leading to the synthesis of bespoke design criteria or sensitivities (Ciolfi & Bannon, 2003), which other educational designers and technologists can adopt and adapt to deploy similar innovations for similar impacts in their respective contexts of learning.

To the two primary axes of impact elaborated by McKenney & Reeves (2012), we add a third area - medial - which centres on key design outputs at the resource level – situated between, and connecting the proximal (practice) and distal (theory). These medial impacts include key, repurposable design artefacts, such as rubrics, evaluation schemas, timetables, software specifications, even architectural blueprints, especially relevant and useful where the focus is on the (re)-design of built educational environments and physical learning spaces (Hall, 2017).

Adapted from, and predicated on the model developed by McKenney & Reeves (2012), Figure 6 illustrates our dynamic and integrative model of design-based research as a cyclical and iterative, principled and participatory process of effecting and systematising change in education.

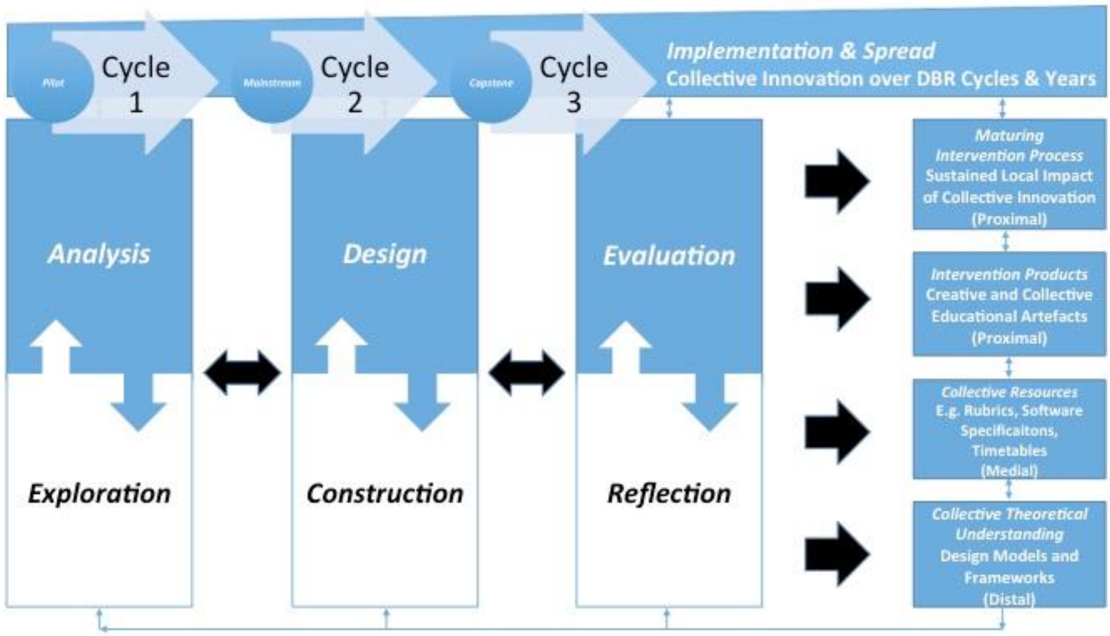

Figure 6. Design-based research as a dynamic and integrative system of collective educational change and transformation

It is important to note that at the local or proximal level, impact is achieved and evidenced not only through a sustained and refined, maturing innovation in context, but also crucially and concurrently, high-quality educational outputs by learners. These outputs include the creative and collaborative educational artefacts and projects learners construct and build as a result of their meaningful engagement and participation in the innovative educational design process. The quality of learners' outputs should improve as the innovation scales and develops over time, and through multiple, interconnected cycles of participatory and principled design in context.

Conclusions

Internet technologies hold the promise of supporting new enhanced forms of political engagement. Building upon the seminal work of John Warfield, this paper presents the case for Applied Social Science and argues for a synthesis of political philosophy, education, and technology design to further support the emergence of a new level of collective intelligence that is increasingly well-matched to the complexity of the societal problems we face. While we currently have plans to embed Warfield's core ISM structuring methodology within the World Wide Web, we believe that collective intelligence design efforts consistent with Warfield vision will require a broader educational and political infrastructure that supports freedom as non-domination as a principle of dialogic engagement in democratic group problem solving environments. While Warfield's methodology has been used in a broad variety of context to address complex societal issues, embedding this methodology into educational and political practice requires ongoing design and evaluation work. We believe that the import of design-based research (DBR) from educational science will allow for iterative design and evaluation of new infrastructures that support new forms of democratic political engagement on the World Wide Web.

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