ARTICLE

The Empty Landscape: A Critical Analysis of The Moral Landscape, in Light of the Requirements of Systems Science

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Morality – principles concerning the distinction between right and wrong or good and bad behaviour; a system of values and moral principles.

Oxford English Dictionary

In his new book, *The Moral Landscape: How Science can Determine Human Values*, Sam Harris (2010, p. 62) makes a bold claim:

> I believe that we will increasingly understand good and evil, right and wrong, in scientific terms, because moral concerns translate into facts about how our thoughts and behaviors affect the wellbeing of conscious creatures like ourselves. If there are facts to be known about the wellbeing of such creatures – and there are – then there must be right and wrong answers to moral questions. Students of philosophy will notice that this commits me to some form of moral realism (viz. moral claims can really be true or false) and some form of consequentialism (viz. the rightness of an act depends on how it impacts the wellbeing of conscious creatures).

While a philosophical emphasis on realism and consequentialism appears, at first glance, altogether reasonable alongside a scientific focus on wellbeing as the fundamental outcome variable for moral decision makers, unfortunately Harris fails to provide a coherent and systematic account of the complex interface between morality, science, and wellbeing. After a brief description of where Harris stands in relation to morality, science, and wellbeing research, I will argue that, in order to defend and develop his view that science can "determine human values" and thus "facilitate human flourishing", Harris will need to develop his understanding of systems science and the challenge of making "good" collective decisions that impact on the wellbeing of conscious creatures (Bertalanffy, 1968; Warfield, 2006). As it stands, Harris presents us with little more than an empty landscape with no tools of navigation to help us survive, adapt, and flourish.

Harris's Science and Morality

Unlike David Hume (Hume, 1740), who argued that there is a clear conceptual distinction between facts and values with only facts – and not values – being open to rational investigation, Harris argues that values can be uncovered by science, because values are reducible to facts in relation to the wellbeing of conscious creatures. We can make "good" or "bad" moral decisions; decisions that impact positively or negatively on our wellbeing. This sounds like a reasonable claim. Harris points to an analogy: just as it is possible for individuals and groups to be wrong about how best to maintain their physical health, it is also possible for them to be wrong about how to maximise their personal and social wellbeing. However, because Harris offers no substantive review of the empirical literature on wellbeing (Keyes & Haidt, 2003; Ryff & Keyes, 1995), and no substantive review of the literature describing the relationship between morally right acts and increased wellbeing (Lapsley & Power, 2005; Peterson & Seligman, 2004), there are no functional relations in Harris's theory. Harris's theoretical position exists largely as a vague a priori assumption. Other than ultimately valuing wellbeing as a superordinate value around which all other values should naturally converge – an issue that is contested by others, including Johnathan Haidt, who describes multivariate value systems with complex interdependencies (Haidt, 2005, 2007) – it is unclear exactly what Harris's subordinate value system actually includes (truth, justice, equality?), or how science might allow Harris to *move through* the moral landscape using this system as a guide. In other words, Harris presents his readers with no theory and no methodology.

Nevertheless, Harris is concerned about the many "bad" decisions that are being made around the world; decisions that impact upon the wellbeing of people such as the continued use to corporal punishment in schools in the southern states of America. However, Harris's anecdotal style of argument tells us very little about the content and structure of psychological science as it pertains to human problems, or scientific methodologies for the resolution of these problems.

Psychological science points to functional behavioural systems that are related in complex ways to wellbeing and moral decision making (Bowlby, 1988; Heckhausen & Schulz, 1995; Mikulincer & Shaver, 2007; Mikulincer, Shaver, Gillath, & Nitzberg, 2005; Reich, Zautra, & Stuart Hall, 2010). This complexity is important for Harris and others to consider. Consider, for example, the literature on the relationship between primary control motivation and wellbeing across the lifespan (Heckhausen, 2000; Heckhausen & Schulz, 1995). Primary control motivation is the motivation to *control the environment*. The argument from evolutionary science and developmental psychology is that control is valued and this "value" impacts upon human wellbeing to the extent that control over the environment is achieved (Heckhausen & Schulz, 1995). Notably, there is no simple relationship between primary control motivation and "moral" action by Harris's definition. Principles concerning the distinction between right and wrong or good and bad behaviour are not necessarily central to how primary control is achieved. The lifespan theory of control (Heckhausen & Schulz, 1995) does not consider moral action aimed at increasing wellbeing to be the fundamental driving force shaping behavior in context; control and mastery and competence are the primary variables in the system. Control (and personal wellbeing) may be achieved at the expense of the wellbeing of others, but control theorists do not factor these variables into their equations, much like Harris ignores the psychology of control. Thus, the question for Harris and other scientists interested in the relationship between moral action and wellbeing is, how can primary control strivings be coopted to facilitate scientific decision making in relation to maximising "moral" or "good" behaviours that foster individual and collective wellbeing.

Evolutionary science points to other functional behavioural systems that may operate in the context of moral decision-making. *Dominance*, for example, is a basic functional behavioural system which may be related in complex ways to wellbeing and moral action. Dominant chimpanzees are those who are more assertive, determined, resolute, and difficult to intimidate in social interactions; they are more successful at forging alliances with others, and better at deceiving others for tactical reasons. In behavioural genetic studies of chimpanzee societies there is a perfect correlation (r = 1.00) between dominance and subjective wellbeing (King & Figueredo, 1997; Weiss, King, & Figueredo, 2000). High-ranking members of primate societies also have greater numbers of offspring than their lower-ranking counterparts (Kenrick, Li, & Butner, 2003), which suggests that dominance plays a role in maximising fitness (i.e., the probability of successfully transmitting one's genetic material to the next generation). In human societies, dominant males have access to more attractive female partners and to larger numbers of females (Perusse, 1993), and in descriptions of fictitious males, dominance (e.g., powerful, ascendant) outranks all other characteristics as the variable that most influences women's judgments of a man's sexual attractiveness (Sadalla, Kenrick, & Vershure, 1987).

Although dominance may serve chimpanzees well in terms of predicting their overall levels of fitness and wellbeing, dominance is correlated in human systems with a huge range of behaviours (Winter, 1973), each of which might be interpreted as more or less "adaptive" or "good" or "moral" depending on the context. For example, Winter (1973) reports that power motivated students held more offices in student organisations; participated in more competitive sports; read more sports and sex magazines; claimed to have higher grades than they actually had; drank more beer and hard liquor; reported having sexual intercourse relatively early; were more likely to choose inconspicuous fellow students as friends; and so on. The list of correlates is long, and any reasonable evaluation as to the emotional consequences of these behaviours has to be conducted in light of the different ways in which the behaviours impact on different people in different contexts. Not surprisingly (and unlike chimpanzee societies), there is no simple one-to-one relationship between dominance and wellbeing in human societies. While dominance and power may be primary drivers of human behaviour, the variable and complex systems of reinforcement that exist in human systems imply that any behavioural pattern deemed "adaptive" or "good" in one circumstance might well be deemed "maladaptive" or "bad" in another (Chang & Sanna, 2003). Again, the question for Harris is how dominance and power might be coopted by scientists to facilitate moral scientific decision making in relation to increasing wellbeing, and what systems of reinforcement scientists might use to facilitate control in this context.

Philosophically, Harris presents a curious mix of rational and idealistic arguments. He notes that "whatever can be known about maximising wellbeing of conscious creatures – which is, I will argue, the only thing we can reasonably value – must at some point translate into the facts about brains and their interaction with the world at large" (p. 11). However, his apparently rational proclamations in relation to brain science are about as profound and useful as saying rather idealistic and vague things like "once we understand brain-behaviour-environment relations we will be able to make good and wise decisions". But nowhere does Harris provide us with a definition of what wise decision making might entail.

Robert Sternberg (2006, p. 216) suggests that wisdom involves:

> …the application of intelligence and experience as mediated by values toward the achievement of a common good through a balance among (a) intrapersonal, (b) interpersonal, and (c) extrapersonal interests, over the (a) short- and (b) long-terms, in order to achieve a balance among (a) adaptation to existing environments, (b) shaping of existing environments, and (c) selection of new environments.

Harris says little about the balance and perspective that will be needed by scientists as they seek to make difficult moral decision, or how science education might be redesigned such that the requisite training in wise scientific decision making is provided. Nor does Harris grapple with the gap between description and control in science. If you wish to address the issue as to 'how science can determine human values' you have to grapple with the issues of prediction and control in human systems, and while Harris appears to abhor any form of moral relativism, the reality of *scientific control* in the context of collective problems implies some coordination of the knowledge and perspectives of the stakeholders who have a vested interest in resolving a particular problematic situation. In the absence of this coordination of perspective and knowledge no consensus and collective design solution can be achieved (Warfield, 2006).

The design of environments that enhance the wellbeing of everyone presents us with a range of both conceptual and applied problems. For example, although Harris refers to the work of Derek Parfit (2011), who has grappled with some of the difficult philosophical questions that arise as a consequence of consequentialism, such as "How should we weigh present wellbeing against future wellbeing? How do we compare the wellbeing of different people?", Harris is inclined to push the philosophers aside and simply endorse his ecstatic view that science will eventually help us to achieve new peaks of wellbeing. And while one might expect the greatest power of reasoning to be demonstrated by Harris in his own research domain – neuroscience – fellow neuroscientists will be disappointed to find very little discussion on the neuroscience of emotions and wellbeing (Immordino-Yang, McColl, Damasio, & Damasio, 2009; Lewis, 2005; Lindquist, Wager, Kober, Bliss-Moreau, & Feldman Barrett, 2011) or the thorny issue of how subjective experiences can be reduced in a meaningful way to states of the brain (Hogan, 2006, 2008a; Rose, 2006). Although Harris describes the results of his PhD thesis, where he found similar brain activation patterns for moral belief and factual belief, he fails to consider the implications of his findings for understanding factual decision making and wellbeing.

As a director of "project reason", Harris demonstrates his capacity for some simple argument mappings, but there is no system to organise his thought and this makes his book very difficult to analyse. His thought is largely incoherent. Philosophically, he is less a contextualist (or pragmatist) and more a formist. Formists seek to maintain a radical freedom in their relationship with the dispersive field of observation, because systematic organisations of facts are not assumed by formists, and if operational principles were used by formists to organise facts, formism would begin to look like mechanism (Pepper, 1942). Harris is not a mechanist, because he nowhere seeks to describe a system. And while Harris seeks to integrate his formist and pragmatist tendencies by endorsing (in principle) both realism and consequentialism, he appears unaware of how difficult it is to achieve this integration on a deeper philosophical level (Hogan, 2009; Pepper, 1942), because moving freely (like a formist) through the field of psychological science, from one set of facts to another, requires some grounding force; something that grounds all the particulars in the field of observation by reference to some character. And perhaps the easiest solution for the formist is to frame these particulars by reference to some universal character that cannot be readily disputed, for example, the character of "human nature" (Pinker, 2002) or "the wellbeing of conscious creatures" (Harris) and then place alongside this universal character some simple mechanistic account of how the discrete forms that constitute this character work together, which some authors at least attempt to do (Pinker, 1997, 2002, 2008). But formism and mechanism always come up short when the ultimate goal is a theory of human development – for example, a developmental account of how movement upward on the moral landscape is achieved – because development itself always points to *process* and by implication to the philosophical stance of organicism (Pepper, 1942; Piaget, 1955), which in turn points to the *function* of any such process and by implication the philosophical stance of contextualism (or pragmatism). Some theories of human development seek to integrate organicism and contextualism (Fischer, 1980), but there is no process and function in Harris's account of values in action, or in his description of how science can determine human values.

Notably, although one of the aims of project reason is to promote critical thinking, none of the projects on Sam Harris's project reason website (http://www.project-reason.org) point to interventions to improve critical thinking. Notably, we have recently been using argument mapping training as a means of improving critical thinking ability in college students (Dwyer, Hogan, & Stewart, 2011a, b). If Harris sought to array the set of empirical facts and relations presented in his book in an argument map (van Gelder, Bissett, & Cumming, 2004) and thus seek to infer from the evidence he presents to the claim that "science can determine human values", he would surely see the empty landscape he has constructed. When the landscape fills with the actions and consequences of real people, and with the principles, systems, and concrete facts that people generate and use as part of their action in real time, the world becomes a much fuller, richer place. Harris needs to return from his state of ecstasy in relation to the value of science as a decision making tool; like the Zen master, he needs to return from nothingness to the forest path where other people walk. It is here where joy and modesty first collide.

The Challenge of Modesty to Joy

As noted by Harris, we can reject all pronouncements on the relationship between moral action and wellbeing if those views ignore or distort the science of wellbeing. Adopting this scientific stance may liberate us from arrogance and ignorance, reason without evidence and decision without evidence. Nevertheless, the "problem" of human wellbeing remains. Only now, in the modern era of science, the facts and relations relevant to a description of the problem (and the various descriptions of the problem itself) have changed.

Broadly speaking, the problem of optimising human wellbeing is a complex scientific and social problem. Resolving complex scientific and social problem is often impeded by three interdependent human limitations: poor critical thinking skills, limited computational capacities, and no clear methodology to facilitate group coherence and consensus design. Third level science education is designed to facilitate the development of generic critical thinking skills, but often does so with limited success (Kuhn, 2005). Furthermore, third-level science education generally focuses on domain-specific computational skills that do not necessarily transfer well outside of the domain in which they are normally used, and training in the use of systems science methodologies that facilitate group coherence, consensus design, and collective action is rarely observed (Warfield, 1974; Warfield, 2006).

I think it is possible to address these problems by offering students of science rigorous training in three thought structuring technologies: argument mapping (AM) for critical thinking, structural equation modelling (SEM) for mathematical modelling, and interactive management (IM) for system design. This integration can best be achieved in the context of the design and evaluation of a new systems science educational tool embedded within a new systems science curriculum. My hope is that Sam Harris and others can use these tools to facilitate good decision making and catalyse collective action focused on enhancing wellbeing. Below I outline this initiative. Notwithstanding Sam Harris's dislike for relativism, I describe first why coordinating perspectives is essential to collective problem solving. Next, I describe the need for a modest systems approach to the resolution of problems that impinge upon human wellbeing. Finally, I describe a new systems science curriculum that will support the computational, reflective, and collaborative evidence-based requirements of collective systems design.

Perspectives and Systems

While Harris appears to value both rationality and scientific control, in the sense that he hopes that scientific moral decision making and action will result in greater wellbeing for all those upon whom these scientific moral decisions and actions have an impact, he makes no reference to applied systems science, or principles of system control that may facilitate his primary objective. To reiterate, while Harris appears to abhor any form of moral relativism, scientific control implies collective problem solving and some coordination of the knowledge and perspectives problem solvers. In the absence of this coordination of perspectives no consensus on the design of wellbeing solutions can be achieved and the power and potential of collective action for the greater good fails to be fully realised.

Naturally, people approach moral and scientific problems from different perspectives. A group of moral "experts" may see the same moral problem from a variety different perspectives (Lapsley & Power, 2005). Dialogue is always needed before any consensus as to the nature of the problem can be achieved (Bohm & Nichol, 1996). The same applies to scientific problems that relate to the design of human systems (Warfield, 2006). Thus, when it comes to predicting the way in which a group of "scientific moralists" might approach problems of human wellbeing, the need to somehow coordinate multiple perspectives can be anticipated.

Why do people construct different models to represent the "same" problem? The answer to this question need not be complex. Consider two decision making systems, each with a limited *working memory capacity* (Miller, 1956) and a *value-filter* that excludes (or inhibits) "bad bits" of information and includes (or selects) "good bits" of information (Hasher, Stoltzfus, Zacks, & Rypma, 1991; Hasher & Zachs, 1988; Kennedy, Mather, & Carstensen, 2004). When presented with the same problem, we can assume that the probability of two independent decision making systems selecting the same bits of information as the "good bits" is less than one, even if we constrain our analysis to identical twins behaving in the same context (Emde & Hewitt, 2001).

Now, let us assume we wish to design a model of "optimal human being" (Sheldon, 2004), where k variables are taken into consideration. Why might different schools of thought emerge in this context? As noted by Warfield (2003), if a school of thought is defined to be an explanation of a problematic situation based on k variables, and suppose that the problematic situation under study actually involves n variables (where n would generally be more than k), then the number $T(n, k)$ of schools of thought that can be formed is given by the formula:

$$T(n,k) = n!/(n-k)!k! \qquad (1)$$

which is the same as the number of combinations of n things, taken k at a time. If all values of k from 1 to n are allowed, the sum over k of $T(n, k)$, which is equal to $2^n - 1$, would give all possible schools of thought. For $n = 7$, which is the average number of items a young adult can hold in short-term memory, this number would be 127. As such, when presented abstractly and mathematically in this way, it is easy to see why there is a high probability that two people seeking to model "optimal outcomes" in a scientific moral decision making context will, when working independently, generate different models. Therefore, one of the major challenges for Harris and others who advocate a scientific approach to moral problem solving, is how best to facilitate consensus design and collective action such that two or more individuals can cooperate to realise the best course of action in any given problem situation.

Modest Systems Psychology

The challenge of drawing upon multiple perspectives in the resolution of moral problems is central to modest systems psychology. Modest systems psychology (Hogan, 2008b) begins with an understanding of the following principles:

1. Sentiment cannot be wholly removed from science and its functional applications (Warfield, 2003, 2004)
2. Collaborative understanding will always be difficult to achieve in a field where competing schools of thought do battle for supremacy (Basalla, 1988; Boyd & Richerson, 2005; Laland & Brown, 2002)
3. Understanding is limited due to the fact that, in equation 1 above, k is always smaller than n
4. Even if an understanding of "wellbeing" is achieved – an understanding that will be limited due to the fact that, in equation 1 above, k is always smaller than n – *controlling* a human system, and thus *promoting* wellbeing, is inherently difficult.

Whereas principles 1, 2, and 3 are all relevant for understanding the process of theory building and hypothesis testing in psychology, principle 4 is relevant if one's goal is to influence positive outcomes. More specifically, Ashby's law of requisite variety (Warfield, 2006) states that for effective control, the variety available to the controller should be the same as the variety available to the system to be controlled. Ashby's law implies that if, for example, a human system to be controlled has n variables, the controller must be able to control all n variables; otherwise they risk the consequences of leaving some subset of those variables uncontrolled. Therefore, if a group of psychologists or a government wishes to control (and develop) moral behaviours in a group, a studious way to proceed is to determine how many variables there are to be controlled, and then make available that same number of control levers to the controller.

Resolving Problematic Situations using Systems Science

Project reason and Sam Harris's book on wellbeing should really address the challenge of science education and applied systems science. Not only does Harris show little awareness of the science of wellbeing, he shows little awareness of the challenge of science education. Resolving complex scientific and social problem is contingent upon the collective action of groups working within an applied systems science framework that incorporates at least five elements. According to John Warfield (2006), systems science is best seen as a science that consists of nested subsciences. It is presented most compactly using the notation of set theory. 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

$$\mathbf{A} \subset \mathbf{B} \subset \mathbf{C} \subset \mathbf{D} \quad \mathbf{E} \qquad (2)$$

We can learn something of systems science by first learning a science of description (e.g., physics, chemistry, biology, psychology, sociology, economics). Then we can learn a science of design that includes a science of description. The science of design is fundamental if our goal is to redesign systems (e.g., the intelligent redesign of school systems via effective knowledge import from biology, psychology, sociology and economics).The science of design implies the use of tools that facilitate the building of structural hypotheses in relation to any given problematic situation, a problematic situation that may call upon the import of knowledge from any given field of scientific inquiry. Next, we can learn a science of complexity that includes a science of description and a science of design. The science of complexity is fundamental if our goal is to integrate a large body of knowledge and multiple disparate functional relations that different stakeholders believe to be relevant to the problematic situation. Next, 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 catalyse collective action for the purpose of bringing about system changes that are grounded in the sciences of description, design, and complexity.

Warfield's vision for applied systems science is instantiated in part in the systems science methodology he developed, interactive management (IM). IM is a computer facilitated thought and action mapping technique that enhances group creativity, group problem solving, group design, and collective action in the context of complexity. There are a series of steps in the process. First, a group of key stakeholders (commonly 50 – 200) with an interest in resolving a problematic situation come together in a situation room and are asked to generate a set of raw ideas about what might potentially have a bearing on the problem they all agree exists. Group discussion and voting helps the group to clarify the subset of ideas that bear upon the most critical problem issues. Next, using IM software, each of the critical issues are compared systematically in pairs and the same question is asked of each in turn "Does A influence B?" Unless there is majority consensus that one issue impacts upon another, the relation does not appear in the final analysis. After all the critical issues have been compared in this way, IM software generates a problem structure (or problematique) showing how the issues are interrelated. The problematique can be viewed and printed for discussion. 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. When the group is happy that they have modelled 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. IM has been used successfully in many different organisations and with many different groups (Broome, 2006; Warfield, 2006). Notably, IM can be used to build problem structures, objective structures, option structures, enhancement structures and so on (see Figure 1 for an example of an enhancement structure).

Perhaps less well developed in Warfield's thinking are: (a) strategies for importing the facts and relations of disparate descriptive sciences into group design efforts, (b) strategies for quantifying problematique model fit by weighting and measuring discrete relations in matrix structures and computing statistical fit indices, and (c) teaching the critical thinking skills necessary for the analysis and evaluation of scientific evidence embedded in problematiques.

In the context of resolving scientific and social problems that call upon the knowledge of stakeholders who are trained in a science of description, it is important to recognise that informed judgments in relation to the facts and relations of science imply the ability to think critically in relation to one's own knowledge and the knowledge presented by others. While a variety of training techniques can be used to enhance critical thinking skills, a recent meta-analysis by Alvarez-Ortiz (2007) suggests that the explicit use of argument mapping training is one of the most effective methods of training critical thinking skills.

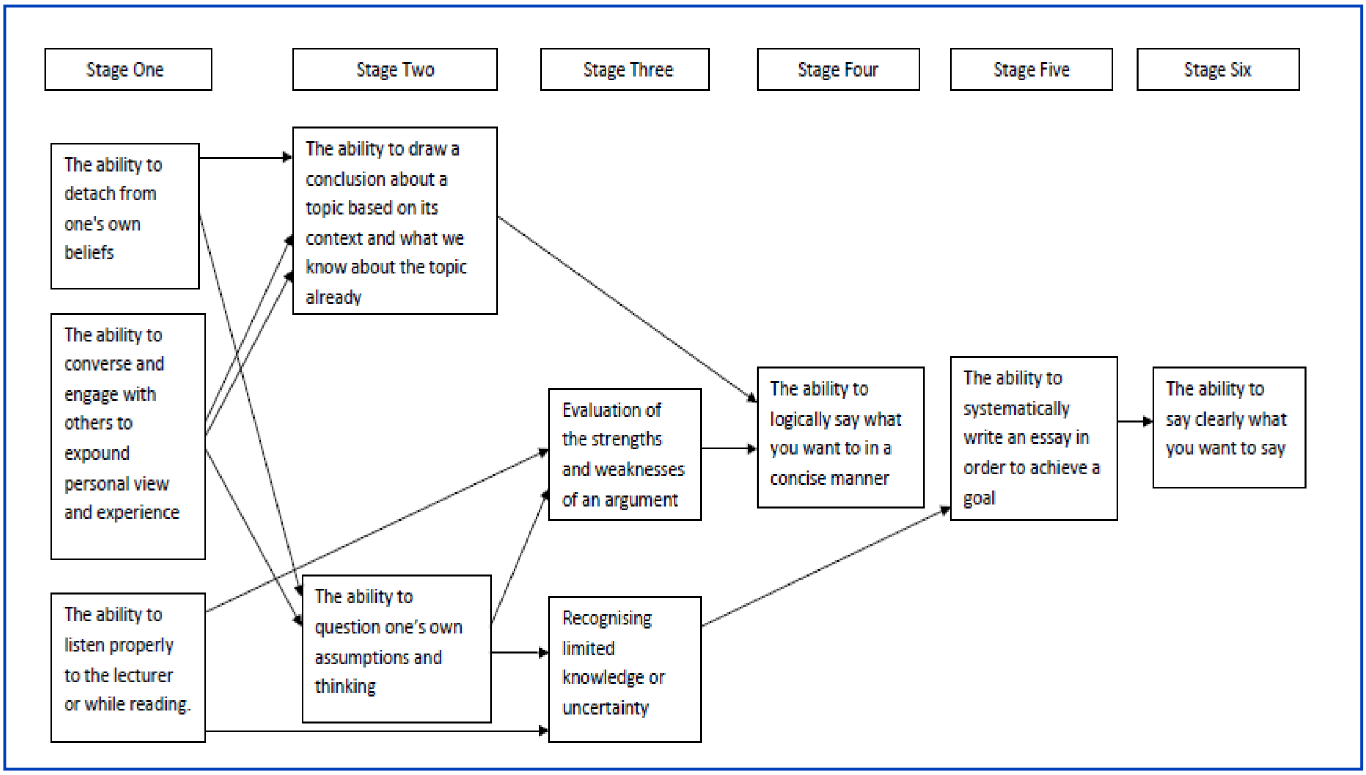

Figure 1. Sample Enhancement Structure of Skills and Dispositions Required for Critical Thinking (Designed by PS410 students as part of introduction to CT and IM. Paths in the model are to be interpreted as "significantly enhances")

Furthermore, with research studies demonstrating the largest gains in knowledge growth and critical thinking skills deriving from cooperative enquiry (Johnson & Johnson, 2009), it is not difficult to see how the development of critical thinking skills through cooperative enquiry using argument mapping tools can fit within Warfield's vision for systems science education. Specifically, if one considered each of the binary relations in a larger structural hypothesis (or problematique) to represent a specific claim (A influences B), then it is easy to see how a structural analysis and evaluation of the evidence used to support this claim can be mapped out in an argument map (see Hogan and Stein, 2010 for more details). Furthermore, with easy access to the Web of Science and other search engines, it is possible for students working together to analyse and evaluate a particular claim in a structure, specifically, by sourcing available knowledge and considering the credibility, relevance, and logical significance of this knowledge to the relation under investigation.

Warfield notes 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 2). IM integrates all three of these components in its design. However, Warfield also highlights the distinction between the mathematics of content and the mathematics of structure. IM draws upon the mathematics of structure to convert matrix voting structures of users into a graphical representation of the relations they have mapped in their problematique. Nevertheless, in the context of mapping problem structures or enhancement structures (i.e., problem resolution structures) that import knowledge from domain-based sciences, it is feasible and perhaps desirable for the purpose of model fit evaluation to estimate effect sizes for discrete functional relation in a matrix structure and thus test the empirical validity of models. Although Warfield notes that the mathematics of structure and the mathematics of content are not altogether distinct, he did not consider their integration in his methodology.

In addition to integrating argument mapping and web of science search features with IM structuring technology, we are developing a systems science educational tool that will incorporate the capacity to import effect sizes for relations in IM structures and thus test model fit. We believe this is important not only if one's goal is to deeply embed descriptive science and critical thinking in systems science education, but also if your goal is to achieve some integration of the applied systems science of Warfield and the computational systems science of Forrester and others (Forrester, 2007).

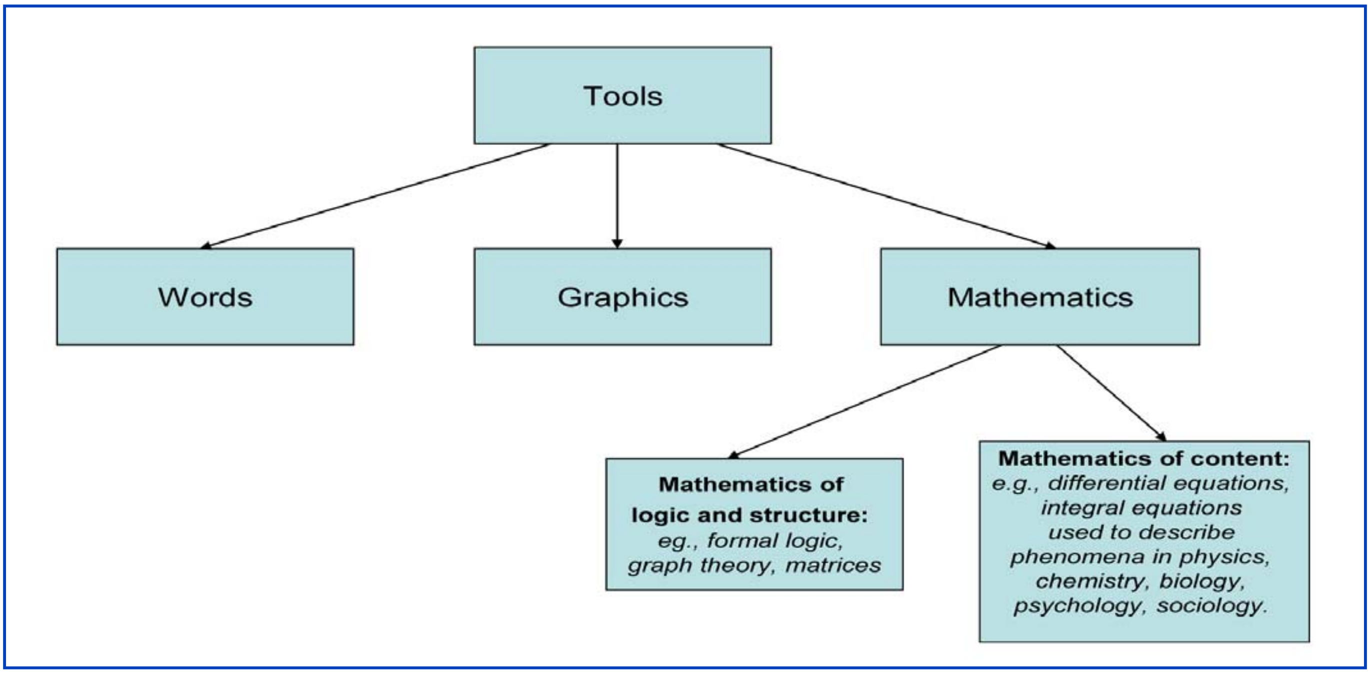

Figure 2. Systems science need to work with our capacity to share meaning using words, represent causality using graphics, and model complexity using mathematics.

Moving Forward on the Moral Landscape and a Logical Approach to Systems Science Education

Harris is probably mistaken in thinking that we can best optimise moral decision making by applying the reductionist strategy of, first, understanding the neural substrates of wellbeing and, second, seeking to align our moral decision making strategies with these optimal brain states. My first objection to this strategy is that current brain research suggests that the complex of emotions associated with wellbeing cannot be easily localised to any given brain area, and are more likely constructed in different configuration across individuals using generic brain networks (Lindquist *et al.*, 2011). This poses a problem for any naturalised ethics that seeks to use brain imaging as a tool to measure "successful" moral decision making. Second, much like the brain operates as a system to construct emotional experience using generic brain networks, so too do people work together as a thought system (Bohm, 1994) to construct solutions to emotional problems using generic forms of thought rooted in our evolved capacity for numeracy, literacy, and graphicacy (Kosslyn, Thompson, & Ganis, 2006; Pinker, 2008; Warfield, 2006). Having said that, the evolving tools of culture may help us work collaboratively to achieve greater logical coherence and cooperative efficiency and efficacy as we seek to solve problems that impinge upon human wellbeing. Rather than adopting a reductionist stance, I think we need to adopt a systems view, and more specifically an applied systems science view that begins with a focus on applied systems science education.

Systems science education is not difficult to implement. Much like Warfield suggested, we can learn something of systems science by first learning a science of description (e.g., physics, chemistry, biology, psychology, sociology, economics). However, in the context of a three or four year science education program, research suggests that one of the best ways to cultivate critical thinking skills in relation to the facts and relations of any given domain-based science is to teach students how to analyse and evaluate the knowledge of their domain using argument mapping tools. Furthermore, the largest effect sizes in terms of growth in critical thinking ability will be achieved if there is a cooperative or collaborative enquiry component to the teaching of science. Therefore, I suggest that during the first year of any science education program, students should take a generic argument mapping training module. This module will include both individual argument mapping work and cooperative enquiry and argument mapping, with the goals of developing the skills of analysis, evaluation, inference, and reflective judgment along with generic graphicacy skills and knowledge search and knowledge import skills.

Next, in Year 2, consistent with Warfield's suggestion, science education should build upon the critical thinking and graphicacy skills students have acquired by providing instruction in the sciences of design, complexity, and action, specifically, by extending their cooperative enquiry skill to the collective design of problematiques and enhancement structures that pertain to more complex scientific and social problems. Finally, in Year 3, students will learn about computation knowledge systems, structural equation modelling, and the evaluation of model fit in the context of system design projects that incorporate knowledge input from students working in disparate domains of science. This final step in the systems science education program will also help students to understand the multidisciplinary nature of systems science and the very real challenge of implementing systems science in the context of real world problems.

Conclusion

I agree with Sam Harris on one point: we need to adopt a scientifically informed approach to the design of environments that optimise human wellbeing. Our moral stance and our selected goals in relation to what is "good" and "bad" in this context must reflect what we know about human wellbeing. However, the logic of system design must not be seen as reducible to the logic of brain networks and it should not be designed around the psychology of the individual alone; it needs also to be grounded in the logic of social networks and applied systems science and it must reflect what we know about collaborative enquiry, systems science education, and the logic of effective collective action.

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