

A Philosophical Axiom Review on “THE METHODOLOGY” of Computing Research

RMM Pradeep¹ and Mike Morris²

¹General Sir John Kotelawala Defence University, Sri Lanka

²World Wildlife Fund -UK & Natural Resources Institute, University of Greenwich, London, United Kingdom

rayantha@gmail.com

Abstract: Computer Science today spans an increasing range of theoretical and practical disciplines in its exploration of what can and cannot be automated, which is giving rise to a greater diversity of disciplinary collaboration. Where collaboration is between individuals from different disciplines then accommodations are needed in agreeing on a research philosophy and developing the research methodology. A review of the general research literature suggested that where research is undertaken by different disciplines misalignment between the respective understandings of the ontology, epistemology and axiology (o-e-a) underpinning the research is not uncommon. Studying the prominent literature, it developed an online mind map to illustrate such misalignment and opened to discussion. The mind map was constructively criticized by experienced researchers from multiple disciplines and able to enhance. In addition to consideration of the different forms of collaboration deployed by researchers – multi-disciplinary, inter-disciplinary, trans-disciplinary – conceptualisations of the problem/enquiry domain itself were examined, as too was the relevance of perspectives by non-research stakeholders, who may be critical to the uptake of research findings. The level and scale of complications entailed by research interventions in navigating complex situations suggest that the nature of o- e-a cannot be determined by any one discipline (i.e., the ‘research as usual’ ticket), but most probably will emerge through collaborative negotiation. The development of such processes has hitherto been marked by the transition from multi-disciplinary to inter-disciplinary research. Where research extends beyond and outside scientific disciplines (i.e., includes non-scientific sources or practice, engages with learning processes from wider society) – trans-disciplinary research – the challenge to academia is establishing whose o-e-a counts, that of the researchers, or that of the knowledge users? This paper explores these options.

Keywords: Complexity, interdisciplinary, Research Methodology, Ontology Epistemology Axiology

1. Introduction

A. Computing research

The research agendas in computing science cover theoretical disciplines such as artificial intelligence, data analytics and information theory, and increasingly extend to

the practical disciplines relating for example to cyber security, fintech, education, climate change and disaster management. All such extensions are inevitably informed by the other existing discipline-oriented theories and research philosophies.

B. Researching Complexity

Despite the undoubted successes of science and technology, and in particular computing science, the contemporary world is confronted with increasingly complex issues (e.g., climate crises, biodiversity loss, health pandemics, governance failures) that are not readily responding to conventional scientific approaches. Research responses have not only included deeper specialization within disciplines, but also greater diversification, as manifested in the growing collaboration between disciplines. (Pradeep & Morris, 2021)

C. Research Requirement

The initial objective of the study was to develop a comprehensive framework for expediting the selection and deployment of the most appropriate research approach/es for a given type of challenge. This was to be undertaken iteratively, and by drawing on the expertise of experienced researchers from different disciplines. It was felt that such a framework might be of particularly useful to research students and for senior academic colleagues charged with advising them.

In the process of advancing the study and engaging with the wider research community, it became apparent that the initial premise relating the research methodology with the philosophical axioms (i.e. ontology, epistemology, axiology), was not immutable, and that typically in complex situations the required methodology, over and above facilitating inter-disciplinarity, needed to enable the integration of scientific and academic knowledge with the different pieces of knowledge of the real-world, non-scientific, problem stakeholders.

D. Objective

These discoveries suggested that rather than the development of a tangible framework, the objective needed to be framed more in extending the mindset of researchers (i.e., from generating new scientific knowledge, to effecting real-world changes), through enhancing their awareness of and responsiveness to diversity of challenges, including

situations of complexity. While there will always be a need for natural or applied science solutions to those problems where a cause-and-effect logic applies, the growing incidence of complex situations requires more innovative and collaborative approaches, including in the field of computing.

2. Methodology

Drawing on 35 authoritative sources from different disciplines, an initial mind-map was developed (Figure 1) setting out the interactions between the philosophical research axioms of ontology, epistemology and axiology, research philosophy and methodology, formulation of the research questions/hypotheses, research design and its components, and following analyses and syntheses culminating in the generation of new knowledge.

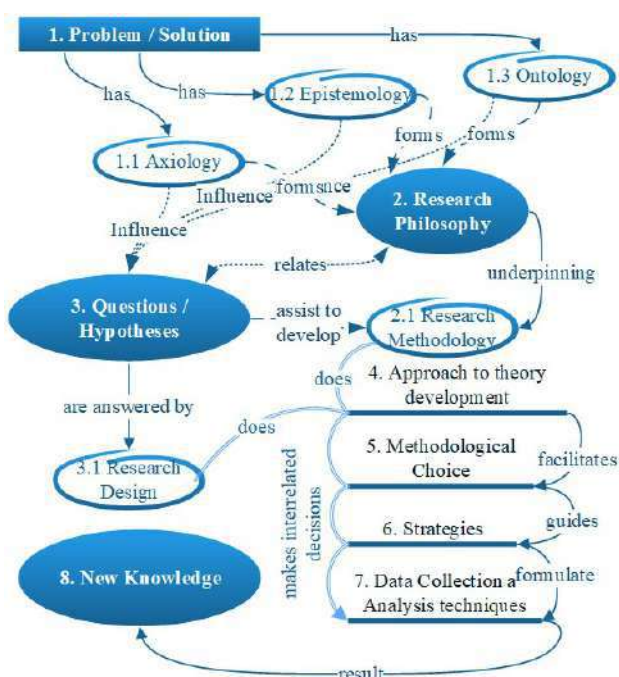


Figure 1. Initial mind-map
Source: (Pradeep, 2021)

Whilst conceived as an organizing framework for the exploration and development of research interventions, the mind map was intended to provide an entry point and fulcrum for discussion for members of the wider research community. The mind-map and explanatory notes were posted on an international research platform, with an invitation for comments. There were more than 500 reads and approximately 50 responses from a self-selecting cross-section of international researchers, a dozen of whom engaged more fully, which included providing references in support of their arguments. These contributions stimulated further reflection, giving rise to another iteration and sharing of the mind-map, but more significantly drawing attention to the centrifugal forces moving research from modest, zero-sum attempts at collaboration between different disciplines – multi-disciplinarity – through to integrative approaches between disciplines – inter-disciplinarity. Most

significantly they pointed to the ineffectiveness of much research in the face of increasing complexity impacting sectors dealing with societal and natural environments, due to a lack of meaningful collaboration with policymakers, practitioners, and civil society. Fortunately, there is a rich and expanding literature on these challenges, which the study is reviewing and continues to draw on, to better identify key considerations and options for research interventions. It is hoped that this discussion paper might be used for/by research students, providing for a fuller understanding of the research challenge.

3. Results and Discussion

Whilst research proposals are amply littered with terms like multi-disciplinarity and interdisciplinarity, and increasingly trans-disciplinarity, all suggesting greater collaboration, they are often used rhetorically and interchangeably, with the nature of the collaboration seldom elaborated. Complexity is a ubiquitous feature of many of the problems impacting sectors dealing with societal and natural environments, which requires high degrees of collaboration. The conventional Newtonian paradigm, premised on physical entities being controllable, measurable, predictable and with a linear logic to equilibrium, and which may therefore be applicable to certain limited technological challenges, is of no use in addressing complexity. Complexity is characterized by many interacting parts, linkages dimensions and processes, and exhibiting non-linearity, unpredictability and emergence (Chambers, 2017). Within any complex system, there may well be non-complex problems (i.e., amenable to mono-disciplinary interventions), but the social and environmental uncertainties, disagreements and limiting capacities of stakeholders cannot be effectively addressed through a mono-disciplinary lens. Ideally, this requires a transdisciplinary approach in which researchers step outside their comfort zone (i.e., research as usual), and seek to blend different perspectives so as to understand scientific questions in their complexity. Trans-disciplinarity involves integrative research between scientific and non-scientific sources or practice, with cooperation among different parts of society, including academia, giving rise to new forms of learning and problem solving (McGregor, 2004)..

Recent studies of complex water problems in catchments in Southern Africa where millions of people may be adversely impacted, reinforce the idea that there is no single research approach that can constructively build on the many, diverse, and often conflicting worldviews and epistemologies held by catchment stakeholders from case study work and a review of the literature, Fallon, Lankford and Western (2021) identify a landscape of possible solutions based on four major dimensions: science, policy, practice, and participation (Fallon et al., 2021). A 'social learning' pilot in the Great Ruaha River catchment, where years of conventional research had failed to reverse the seasonal drying of the once perennial river, identified shortfalls in catchment governance, and specifically pervasive weaknesses in critical integration dimension (e.g. within and between sectors; of local people and the private sector; in

Author Biography

upstream-downstream working; in the devolution of climate change adaptation; and between practice, research and policy-making) (Morris & Chonya, 2016).

There can be no room for research that does not acknowledge or engage with these broader contextual dimensions. Worse, siloed research disciplines and the dominance of conventional research methodologies (i.e., empirical, interpretive, and critical), bound to their own notions of epistemology, ontology, and axiology, threaten causing a fragmentation of contemporary knowledge.

4. Conclusion

Academic ways of knowing have proven inadequate in the face of growing socio-ecological complexity. Whilst good research is undoubtedly being undertaken, slavish adherence to longstanding research methodologies (e.g., empirical, interpretive, critical) – the ‘research as usual’ approach – is undoubtedly limiting the applicability of much research to real-world situations. Academia generally but research students in particular need to be facilitated in understanding the implications of complexity, in recognizing the diversity of perspectives, and in respecting the plurality of knowledges, in their efforts to create a deeper, more effective understanding of reality.

Acknowledgment

Authors pay their sincere gratitude to all the experts and researches who participated in the discussion on mind-map.

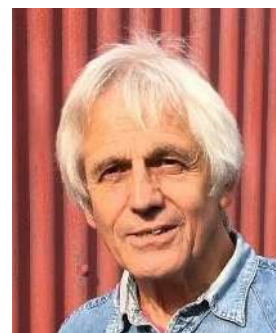
References

- Chambers, R. (2017). Can We Know Better? In *Can We Know Better? Reflections for Development*. Practical Action Publishing Ltd. <https://doi.org/10.3362/9781780449449>
- Fallon, A. L., Lankford, B. A., & Weston, D. (2021). Navigating wicked water governance in the “solutionscape” of science, policy, practice, and participation. *Ecology and Society*, 26(2). <https://doi.org/10.5751/ES-12504-260237>
- McGregor, S. L. (2004). The Nature of Transdisciplinary Research and Practice. *Kappa Omicron Nu Human Sciences Working Paper Series*, January 2004, 1–12. <https://kon.org/hswp/archive/transdiscipl.pdf>
- Morris, M., & Chonya, C. (2016). SWAUM: Making Catchment Governance Work for All - The Integration Challenge: Putting the ‘ I ’ in ‘ IWRM ’! In *Sustainable Water Access, Use and Management (SWAUM) Programme 2011-2016* (Issue October). <https://doi.org/10.13140/RG.2.2.26685.56800>
- Pradeep, R. M. M. (2021). *How Ontology , Epistemology And Axiology Relate To Develop New Knowledge Through Research Methodology And Research Design* (Open for Discussions, Issue October). <https://doi.org/10.13140/RG.2.2.13395.50721>
- Pradeep, R. M. M., & Morris, M. (2021). The Complexity of Research, and Researching Complexity: A Review of the Options. *International Symposium of Rajarata University 2021 (ISymRU 2021)*, 2021(December), 82. http://www.rjt.ac.lk/isymru/forms/ISymRU_2021_Proceeding.pdf



RMM Pradeep is a Commissioned officer of Sri Lanka Army where he has been a senior lecturer since 2015 in Faculty of Computing, General Sir John Kotelawala Defence University. His research interests lie in the area of HydroGIS framework, System analysis and design and software modelling &

processing. Pradeep has served on roughly twenty-three years in different assignments in arbovirus vector research, military IT resource management and Computing and Geoinformatics research.



Mike Morris is an advocate and facilitator of systems approaches in addressing the challenges of complex – ‘wicked’ – issues. He has worked as a social development and governance adviser with WWF-UK (2007-2017), senior scientist with the Natural Resources Institute

(1999-2006), country director and programme manager in Namibia and Sudan respectively, for Voluntary Service Overseas (1987-2005). Most recently he has lent support to WASH programmes in Ethiopia, Uganda, Kenya and Bangladesh.