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INTERDISCIPLINARY RESEARCH: CONCEPT, PROSPECTS, OBSTACLES AND RECOMMENDATIONS.

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Abstract:-*Interdisciplinary Research has, of late, caught the imagination of the researchers, academics and institutions because of its focus on solving the problems whose solutions lie beyond the domains of a single discipline. Though the necessity of interdisciplinary research seems to be contemporary, its practical relevance is not new. Various research scholars whose discoveries are the foundations of the fundamental sciences were in fact interdisciplinary contributing significantly across multiple disciplines. The objectives of the this paper are to: (1) understand the concept and characteristics of interdisciplinary research, (2) underscore and clarify the semantics of terms such as intradisciplinary, multidisciplinary, cross-disciplinary, interdisciplinary and transdisciplinary by drawing up on their differences and showing their inter connections through a diagrammatic conceptual loop, (3) describe the prospects and success of interdisciplinary research in areas such as Climate Change Science and Women's Studies, and importance of combining with social sciences in conducting scientific research projects on solar radiation management strategies and (4) highlight up on the benefits of and obstacles in interdisciplinary research and recommending certain measures that will help foster success in interdisciplinary research projects.*

Keywords :

Interdisciplinary Research; Multidisciplinary; Cross-disciplinary; Transdisciplinary; Prospects of interdisciplinary research; Obstacles and recommendations.

INTRODUCTION

Interdisciplinary Research is an essential resource for addressing emerging problems, resulting in important social benefits. The more robust model of interdisciplinary practice will lead to better science by providing resources for understanding the types of value decisions that are entrenched in research models and methods, offering resources for identifying the ethical implications of research decisions and providing a lens for identifying the questions that are ignored, under examined, and rendered invisible through scientific habit or lack of interest. In this way, we will have better science both in the traditional sense of advancing knowledge by building on and adding to our current knowledge as well as in the broader sense of science for the good of, namely, scientific research that better benefit society.

CONCEPT

Interdisciplinary research is a "unique form of team research in which individuals representing different areas of expertise are brought together to work on a common problem and their efforts are integrated into a cohesive whole (Birnbaum, Philiph H. 1981).

"Interdisciplinary research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a

single discipline or area of research practice." (National Academies Report, 2004).

Numerous scholars have discussed the characteristics of the interdisciplinary concept, and from their combined wisdom, following characteristics may be mentioned:
(1) Different bodies of knowledge are represented in the research group,
(2) Group members use different problem solving approaches in attempting to solve problems,
(3) Members of the group perform different roles in solving problems,
(4) Members of the group work on a common problem,
(5) There is group responsibility for the final product,
(6) The group shares the common facilities
(7) The nature of the problem determines the selection of group personnel, and
(8) Members are influenced by how others perform their tasks.

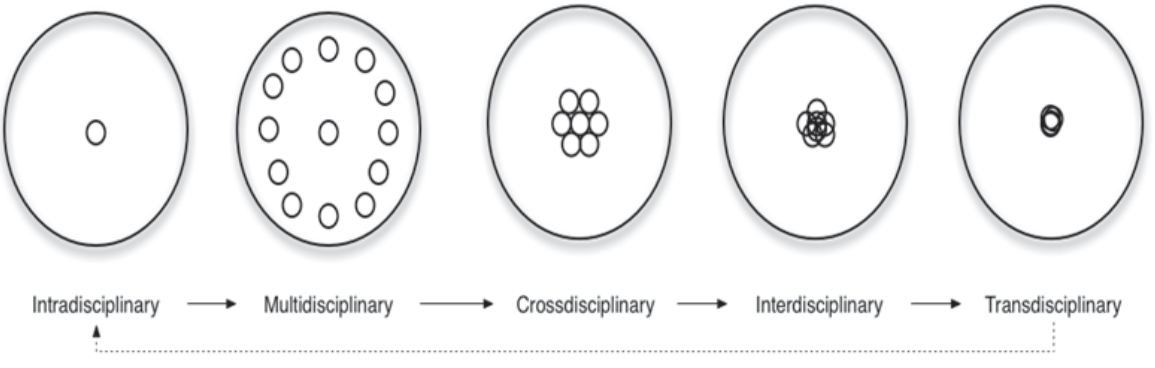
Research problems may also be characterized by a number of attributes which include:

(a)Whether it is applied or basic research,
(b)Whether there is a clearly identified client for the research results,
(c)Whether the problem is easy or difficult to solve, and
(d)Whether there is interaction required between the research workers by the very nature of the problem itself.

The solution of research problems with each of these characteristics may be enhanced or hindered by whether the research team is more or less interdisciplinary.

SOME OTHER TERMS

Intradisciplinary : working with in a single discipline.
Multidisciplinary Research – It refers to research where a number of researchers representing different disciplines or departments are brought together, but the problems tackled by the individual scholars do not require the integration of the research on the specific problem in question. Each scholar works on problems relevant to his/ her own discipline. In multidisciplinary research, people from different disciplines work together, each drawing on their disciplinary knowledge.
Cross disciplinary : viewing one discipline from the perspective of another.
Interdisciplinary : integrating knowledge and methods from different disciplines, using a real synthesis of approaches.
Transdisciplinary : Creating a unity of intellectual framework beyond the disciplinary perspectives.



Although there is not always agreement on these definitions, it is clear that areas of research are dynamic – continually emerging, melding, and transforming. What is considered interdisciplinary today might be considered disciplinary tomorrow.

PROSPECTS FOR INTERDISCIPLINARY RESEARCH

Interdisciplinary research is a social activity which offers opportunities for useful scientific collaboration and technical service to the improvement of the world community. It is "the most significant institution for modern technology development (Layton, E, 1977)."

The success of interdisciplinary operations research group had been spectacular in some cases as in the World War II Battle of Britain and the discovery of the structure of the DNA molecule by Watson, a biologist, and Crick, a physicist. These and other successes focused world attention on forming scientific research problems across

discipline boundaries to solve problems of national and global concerns. Successful interdisciplinary research is perhaps hardest to find within the universities. Academic interdisciplinary research faces unique problems and differs in several important respects from other forms of research more exclusively covered in the literature. The long-term commitment of full time scientists involved in government and industrial research ultimately becomes subject to criteria of usefulness or return on investment. However, academic research takes place within universities whose major goods include teaching, service and research. Here it has generally been the part-time activity of faculty who have focused, usually as individual scholars, on problems defined by their discipline. The very concept of a collaborative team effort between disciplines runs counter to the department and school organization of the modern university and the idealized concept of the lone independent scholar.

Climate Change Science and Interdisciplinary Research

Climate variability and change have significant impacts in relatively short time periods on precipitation, sea level rise, and ocean currents, and how these changes in turn can lead to loss of agricultural and forest productivity and stresses on both natural and managed ecosystems. Interdisciplinarity would assist in both understanding the nature of these impacts and proactively planning for their consequences by encouraging the advancement of models that "included coupled and interactive representatives of ecosystems, agricultural working lands and forests, urban environments, biochemistry, atmospheric chemistry, ocean and atmospheric currents, the water cycle, land ice, and human activities. The realization of these goals demands the engagement of diverse interdisciplinary teams of experimental, theoretical modeling and computational researchers, including but not limited to, biologists, chemists, computer scientists, geoscientists, material scientists, mathematicians, physicists cyber infrastructure specialists, and social scientists (Roy, Eric D, et al, 2013).

Absence of the humanities is clearly underscored. Recognizing that coupled nature/ human interactions can, and in the case of climate related impacts, will raise profound questions of both spatial and temporal justice (e.g., distributive justice and intergenerational justice), as well as complex questions of procedural justice, the absence of philosophers is difficult to understand. In many of these domains epistemic decisions, such as decisions regarding how to set up climate impact models, which data to include or exclude, can have important ethical impacts.

Let us take an illustrative example of a coupled epistemic–ethical issue to underscore the importance of the humanities to interdisciplinary challenges and the huge loss to knowledge that will result from framing the interdisciplinarity in such a way as to exclude the humanities. Consider the example of ice sheet models. While recent improvements in ice sheet modeling may be shifting this decision, data on ice sheet dynamics has not been included in models forecasting sea level rise. This decision was made due to scientific consensus of ice sheet models, for example to be able to reliably forecast increase in ice sheet movement, or predict dynamical changes in a warming ice sheet or to adequately reproduce ice streams. A coupled ethical–epistemic analysis would render transparent the epistemic decisions regarding reliability and robustness of this data, examine the question of an adequate decision process (including questions regarding "adequate for whom and for what") for determining whether and what data is sufficiently robust to include in models and how best to do so, and provide resources for better understanding the implications of not including this data into integrated assessment models (IAMs). For example, the Intergovernmental Panel on Climate Change (IPCC) projections of sea level rise for the twenty first century have not so far included this data. As a result, the models are overconfident, predicting a significantly lower sea level rise during this century than is warranted, an intrinsic ethical issue, which is turn has an impact on how this aspect of climate science is deployed to inform adaptation policy such as decision to build levees or dykes in coastal cities, an extrinsic ethical issue.

There are a number of complex problems facing the nation that can only be solved through interdisciplinary research that catalyzes new approaches. Theories, methodologies, analytic techniques, and findings robustly understood in one field can have a catalytic effect when brought into contact with those of another. Moreover, interdisciplinary endeavors also increase the human capacity of the nation to address difficult problems. The social scientists and philosophers, deeply embedded in research teams, can begin to partner with scientists and engineers to render transparent the types of value decisions that are entrenched in research models and methods and identify the ethical implications of research decisions, as well as begin to examine the questions that are ignored, under examined, and rendered invisible through scientific habit or lack of interest.

In the past decade, scientific and engineering proposals to deliberately modify the climate through solar radiation management (SRM) have burgeoned. One form of geo-engineering involves increasing Earth's albedo by deploying sulfate aerosol in the stratosphere or by increasing cloud cover in order to change the Earth's albedo in such a way as to scatter and reflect sunlight, with the ultimate goal of cooling the planet. Those studying this form of geo-engineering are well aware that it can have potentially harmful impact such as changing regional precipitation and evaporation patterns around the world. And since there will likely be regional variations where some regions may receive overall benefits, while others may not benefit and may even suffer greater harm, issues of distributive justice are clearly raised. The relative appeal of different levels of solar radiation management depends on the region considered and the variable temperature or precipation that is deemed most important. These and other potentially

harmful impacts of SRM with aerosol injections have resulted in a general appreciation of the fact that research on and potential deployment of geo-engineering raises important ethical issues. Social, behavioral, legal and ethical issues will be important in many cases of solar radiation management research. Scientific, legal, ethical, and societal issues, regarding the climate modification scheme are many.

Nine key fields of coupled epistemic–ethical analysis relevant to solar radiation management may be identified as the following (Tuana, Nancy. 2013):

1.Whether SRM can in fact be tested.
2.What are the coupled scientific–ethical issue relevant to SRM pre-deployment for testing?
3.Are there political risks of conducting SRM research?
4.What are feasible climatic trajectories?
5.What knowledge, institutions, and decision processes are needed for responsible decision making?
6.What are the distributions of benefits and harms along the trajectories for what entities? Will those harmed be compensated?
7.How do we value different climate trajectories?
8. How fast (if at all) could we learn?
9. How is geoengineering to be controlled?

Regarding the question as to whether solar radiation management can in fact be tested, what we level a meta-theoretical question, we argue that natural experiments (Volcanic eruptions) and proposed small scale field studies involving partial deployment may not be sufficient for inferring system response at the global level. Non-linear feedbacks can lead to bifurcations of the climate system, where for small forcing, the climate remains unstable but as the forcing increases, the climate system can reach a critical threshold where it transitions to unstable conditions. Given this, knowledge regarding such non-linear feedback may not be testable. In addition, we demonstrate that delayed system response to forcing may also not be testable in that ocean and atmosphere response time to external forcings such as SRM is fundamentally different, hence findings from regional deployment will not apply to full scale deployment due to differences in the temporal response time between spatial scales, leading to concerns about the viability of field tests to determine the safety of SRM deployment (Wear, David N. 1999).

Given these conclusions, namely, that we may not know with confidence how the planetary system will respond to solar radiation management until full deployment and perhaps long after deployment has ended, this led us to the identification of a series of coupled ethical scientific research questions relevant to solar radiation management pre-deployment for testing. In this domain, a series of coupled research issues are identified as following:

(1) What can be inferred from the limited scale experiments about the potential of a full scale experiment, and what can not? Will this knowledge be adequate for making a responsible decision? Will this knowledge be sufficient to warrant the risks of field–testing?
(2) Is it possible to estimate the large-scale system response from a small-scale field test?
(3) What side-effects will result from pre-deployment and can they be predicated?
(4) What are the costs of the side effects of field testing?
(5) What are the bounds of permissible field testing in terms of spatial and temporal extent as well as the degree of environmental modification and intrusion?
(6) Are there field tests, i.e., SRM pre-deployment for testing that would incur only modest risks of significant side effects? What level of confidence would be ethically adequate to conduct such tests? What can be learned from such tests?
(7) What scientific and ethical knowledge it required to responsibly decide whether to start SRM field testing? What is the basis for deciding on acceptable risk levels for field testing? What level of learning would justify risks of side-effects?
(8) What measures of impacts would be used to determine that the costs of field testing are higher than the benefits of field testing and should be halted?
(9) What is the boundary between field testing and deployment?
(10) Will some regions be more harmed by SRM field testing than others?
(11) Will those nations/ regions/individuals harmed by SRM field testing and/ or deployment for geoengineering be compensated?
(12) Who will be responsible for potentially required compensation and how will compensation be determined?

The general conclusion of coupled scientific ethical analysis of solar radiation management strategies leads us to the conclusion that:

(I) this type of research practice with its attention to coupled ethical epistemic analyses is an essential element of improving research in this area of science; and
(II) that given the importance and value of this type of research, funding agencies should modify funding mechanism to encourage and support these types of coupled research practices.

PROSPECTS OF INTERDISCIPLINARY RESEARCH IN WOMEN'S STUDIES

From the outset, Women's Studies made no secret of the fact that it aimed at crossing disciplinary boundaries. Since the drama of life does not take place in a glass womb, subject compartmentalization needs to be broken down in order to both study and survive, what was emphasized in Women's Studies were interconnections, continuity and interrelationships: the compartmentalization of knowledge was- and by some of us still is- explicitly opposed.

In Women's studies, interdisciplinarity requires considerable reflection, creativity, and innovation, combined with effective strategic planning and the building of wide, constructive institutional alliances and relationship. It is the time to create the organizational structures that promote rather than deter interdisciplinary scholarship, including interdisciplinary Ph.D. programs. As the founders of women's studies increasingly achieve senior status in the academy, they will gain the leadership opportunities to effect such change. Today, as at most known points in modern history, feminism continues to be demonized in the political process. Dissension marks the ranks of women's studies scholars and that a few are publishing their disaffection from the field, reinforcing the worst fears of our critics both inside and outside the academy. In light of such developments, some may worry that efforts toward greater interdisciplinarity in women's studies research and scholarship will make our work seem more marginal rather than more central. Disciplines rule the world of academy (Allen, Judith A. and Kitch, Sally L. 1998).

Such worries are the catch -22 under which women's studies has operated for a quarter of a century. Fear of marginalization had marginalized us. In truth, it seems that failing to define as interdisciplinary women's studies scholars establishing an interdisciplinary research profile for the field has fueled opponents' objections and paralyzed these scholarly change agents inside the university. We can become an "interdiscipline" like pediatrics or religious studies and in so doing achieve institutional status, without compromising the epistemological and ideological complexity of our field. Facilitating and promoting interdisciplinarity will not eliminate the need for important discipline based work in history, sociology, literary studies, philosophy and scores of other traditional fields. But if we agree that interdisciplinarity is an important key to the identity of women's studies and if we agree that we need more scholarship that reflects the element of our identify, then our best hope lies in taking such a position firmly and making it happen.

BENEFITS OF AND OBSTACLES IN INTERDISCIPLINARY RESEARCH

Benefits of interdisciplinary research include fostering the ability to view issues from diverse perspectives, the evaluation of complex problems related to environment, the establishment of broad networks of idea sharing and student enthusiasm. Conversely noted drawbacks include the time necessary to learn about other disciplines, differing levels of personal commitment, difficulties with communication between colleagues, challenges with publishing, a lack of encouragement to explore topics beyond the focus of a department or adviser and the trade-off between interdisciplinary breadth and disciplinary depth (Crow, Gary M, et al. 1992).

Some other challenges of interdisciplinary research include:

- Tension during interdisciplinary research occurs often with both departments and institutions.
- Trouble publishing research results because the research did not adhere to or fit neatly within traditional disciplinary frame works.
- Tension with collaborators during interdisciplinary research due to difference in their methods, theories, or approaches (Curato, Nicole C. 2013).
- Communication difficulties are the greatest challenge to interdisciplinary research.
- Difference in perspective, culture or methodology for the natural and social scientists.
- Difficulty understanding multiple disciplines.
- Issues related to time and funding as big obstacles.
- Negative perceptions of interdisciplinary research by traditional disciplinary specialists.
- Limits to career advancement.
- Lack of existing research methods and standards,
- Difficulty with initiating collaboration.
- Problems with team management.
- Lack of training or mentorship, and
- Dominant traditional reductionist epistemology.

RECOMMENDATIONS

Interdisciplinary research has great value in addressing inherently complex issues. The following recommendations will help foster success in interdisciplinary projects:

(1)TEAM BUILDING – The success of interdisciplinary research projects is strongly linked to the strength of the team. It is recommended that researchers engaging in new collaborations discuss the challenges inherent in the development of an interdisciplinary project at the outset to foster self-awareness and successful outcomes.
(2)OUTSIDE FACILITATORS – An outside facilitator should be brought in to help direct an interdisciplinary team, which can provide helpful guidance.
(3)MULTIPLE GUIDES FOR RESEARCHERS – Graduate and post doctoral positions with dual or multiple guides or advisers can also help bring together senior researchers across a perceived disciplinary divide.
(4)INSTITUTIONAL REWARD SYSTEM – Success in the academic environment is measured largely through the production of scholarly manuscripts. Interdisciplinary research groups tend to initially produce fewer publications per year, but over a 10 – year time span, publish almost twice as many manuscripts as discipline–specific teams do. In the context of promotion and tenure, administrators and senior faculty members need to recognize that interdisciplinary projects may result in a time delay of perceived success, but the resulting measurable success is likely to be large.
(5)FUNDING OPPORTUNITIES – Steps should also be taken to increase access to funding opportunities designed to promote the development of interdisciplinary teams, thereby cultivating a more interdisciplinary university culture.
(6)FOUNDATION IN EDUCATION AND TRAINING – Finally we suggest an increased emphasis on developing interdisciplinary breadth not only in graduate education but at the undergraduate level, as well. Interdisciplinary undergraduate degree programs, research experiences for undergraduates, and interdisciplinary courses focused on topics of high societal relevance can aid this process.

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