

# TRANSDISCIPLINARY SCIENCE METHODOLOGY

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## Abstract

The purpose of this study is to analyze the fundamentals of transdisciplinary science methodology. Transdisciplinarity requires the interactions and iterations of many different scientific disciplines. It is targeted to the problem solving optimization.

In science methodology interdisciplinary or pluridisciplinary approach gets in general specific knowledge from each disciplines and makes a synthesis. De facto this is a case of under optimality. Transdisciplinarity requires that scientist or scientists contributing to the research, are targeted to the defined problem interactions, iterations. They are aiming to understand each discipline's specific approach, by using input of various scientific disciplines and through several interactions with each other, converging to the targeted problem solution optimization. It avoids, specifically in social sciences, the subset and partial analysis approach which is quasi systematic and under optimal.

To illustrate this transdisciplinary science methodology we may consider that nanoscience and nanotechnology, due their pluralistic and interaction structures, are de facto transdisciplinary.

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**Keywords:** Transdisciplinary science methodology, interdisciplinary, problem solving optimization, scientific approach

## Introduction

In last few decades, the scope of science has been changed and its structure is constantly evolving. As the science progresses over the time, it manages to deal with more complicated issues and manage to come up with more enhanced scientific explanations and solutions. Due to the iterative and evolutionary nature of science, as soon as a question answered, more complex ones emerge. In last few decades, most of the complex scientific issues exist in the domain of multi scientific criteria disciplines. To deal with such sophisticated questions with high degree of complexity requires the cooperation of multiple scientific disciplines simultaneously and in a set structure approach.

Some Comments on Transdisciplinary Science Methodology

The complex scientific issues that deals with multiple disciplines require a new scientific methodology approach and those approaches can be categorized under three different categories:

- Transdisciplinary Science Methodology :“Collaboration in which exchanging information, altering discipline-specific approaches, sharing resources and integrating disciplines achieves a common scientific goal”. (Rosenfield, 1992)
- Pluridisciplinary (Multidisciplinary) Science Methodology: Researchers from different disciplines cooperate with each to a certain point in project; however they have different set of question and possibly separate conclusions. (Washington University School of Medicine)
- Interdisciplinary Science Methodology: Researchers interact with each other and transmit information between disciplines.

Interdisciplinary or pluridisciplinary science methodologies have a main structural difference compared to transdisciplinary science methodology. In interdisciplinary or pluridisciplinary approaches, the first step is to obtain general scientific data from each discipline. Then the second step is to combine and aggregate them and make a synthesis as an end result. It is important to mention one fact at this point: the sum of the subsets' optimal is not equal to the set optimal. This theorem can be summarized with the formula below:

Theorem:  $\Sigma$  subsets' optimal  $\neq$  Set Optimal(Güvenen, 2008)

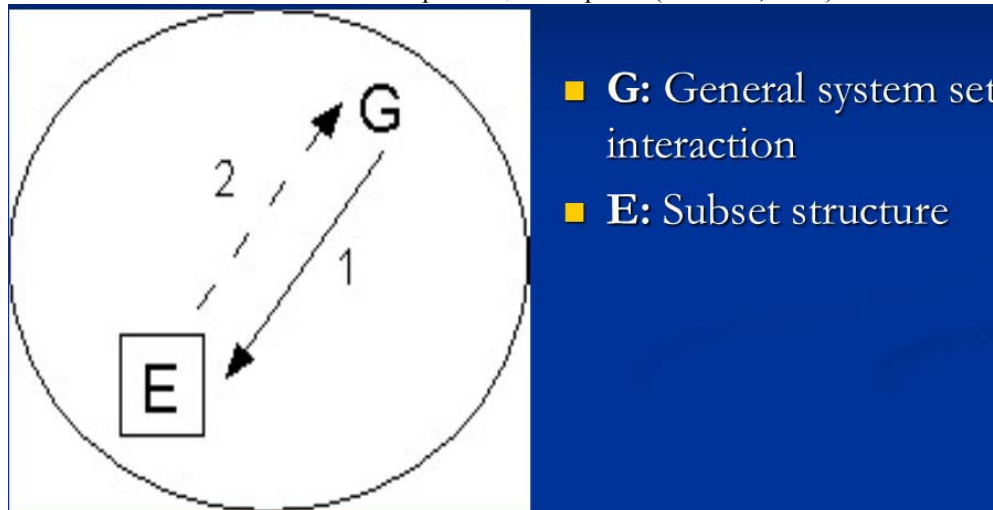


Figure 1: General system and subset interaction (Güvenen, 2000)

The figure above represents the interaction between general system set and subset structure. It is clearly shown that the interaction between two sides are not equally balanced. General system set structure has strong impact on subset structure. On the other hand subset structure has somehow limited effect on general system set.

In the light of the information provided by the theorem it is possible to estimate that both approaches, interdisciplinarity and pluridisciplinarity, leads to solutions which are under optimal and cannot use the full potential of the scientific disciplines which are used in the research.

To find the optimal solution, it is mandatory to use another scientific approach. Transdisciplinary science methodology is the approach that can solve the problems of the other scientific methodologies. Transdisciplinary science methodology can be defined as the method which every scientist who contribute to the research, use the data and knowledge from various scientific disciplines, interacting with the scientists from other disciplines and through these interactions converging to the targeted problem solution optimization. This approach avoids the common problems and shortcomings of both pluridisciplinary and interdisciplinary science methodologies. The set optimal is endogenous to the transdisciplinary science methodology.

Transdisciplinarity can be defined with three common traits:(Güvenen, 2010) (Güvenen, Öztürk, 2008)

- Being targeted to complex phenomena
- Working in an iterative approach
- Cooperation of various sciences and disciplines

The three traits mentioned above constitutes the back bone of transdisciplinary science methodology. Even if one of them is absent, it is not possible to discuss about the existence of a transdisciplinary approach.

Once Albert Einstein said : "The significant problems we face cannot be solved at the same level of thinking with which we created them" (qtd. Chestshire). Being a great visionary

and extremely talented scientist, Einstein was aware of the fact that we have to develop an exterior point of view to see the whole picture and create an optimal solution. It is not possible to solve a problem of a specific discipline by using only the data, knowledge and methods of that scientific discipline. Input from various other scientific disciplines and contribution of scientists with different sets of skills are required to come up with an optimal solution. Interdisciplinary and pluridisciplinary approach focus on the subset and partial analysis which lead to quasi systematic and under optimal end solutions. That is the main reason why transdisciplinary science methodology should be embraced in the solution of scientific problems.

A recent report from American Academy of Art and Sciences underlines the importance of transdisciplinary approach in a constantly evolving world with these words: “Research fields are evolving, and the lines among disciplines are blurring, leading to the emergence of new fields of study that span disciplinary boundaries and allow dramatic advances that no one field could have achieved in isolation. Even traditional disciplines as they are defined today differ substantially from their initial incarnations. Life sciences and medicine (LSM) increasingly relies on sophisticated instrumentation, intensive computational resources, and systems approaches that depend on close collaboration with physical sciences and engineering (PSE). PSE-derived nanotechnologies are bringing applications of quantum mechanics to the real world and advancing breakthrough technologies such as quantum cryptography and computation. Committee concludes that the objective is to achieve transdisciplinarity—to integrate fields beyond the levels of the multidisciplinary...” (American Academy of Art and Sciences, 2013)



Figure 2: Transdisciplinary Science Methodology and Education (Güvenen, 2009)

One of the most important areas which transdisciplinary approach should be applied is the education system. The existing education structure generally is based on “department” system. “Department” dominantly transmits an education of subset and partial analysis. It does not provide the methodology of linking subsets within the broader set structures. This creates in the medium-long term; mechanistic, short-termist approaches in the society, especially in social sciences. It is a fact that, the alternative costs of this approach are observed in the 20th century. 21st century science, research, analysis requires transdisciplinary methodology in order to deal with high complexities and provide feasible solutions.

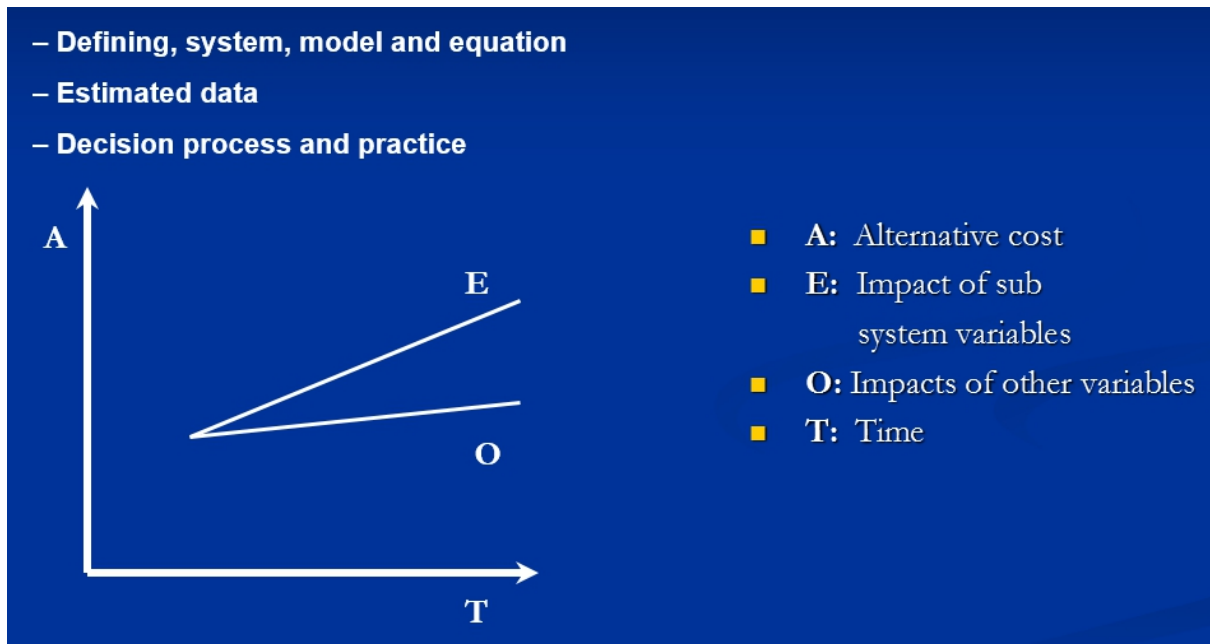


Figure 3: Transdisciplinary Science Methodology and Strategic Anticipation(Güvenen, 2000)

Obtaining data, making observations and anticipating the future trends carries significant importance in scientific progress. Figure 4 visualizes the strict relation between science methodologies and strategic anticipation. As it can be recognized from the figure the particular scientific approach has serious impact on the end result. Choosing a suboptimal scientific approach can end up with serious alternative costs. To get the minimum error margin result and come up with the optimal strategic anticipation, it is important to choose a scientific approach which takes into account the impact of sub system variables, other variables and general set structure at the same time. The scientific approach which can provide optimal solutions for these factors is transdisciplinary science methodology.

### Conclusion

Science methodologies in the 20<sup>th</sup> and 21<sup>st</sup> centuries, especially social science methodologies, dominantly used subset and partial analysis approach. Along with providing short term solutions in the analysis of social and economic phenomena, subset approach and partial analysis approach creates, especially in the medium-long term; mechanistic, short-termist approaches and non-negligible alternative costs.

A new point of view is substantially needed to overcome these problems. A short analysis from a research about transdisciplinary approach summarizes the issue: “In a world characterized by rapid change, uncertainty and increasing interconnectedness, there is a growing need for science to contribute to the solution of persistent, complex problems” (Hadorn, 2008)

All the information mentioned in the previous parts of this paper, shows the importance of transdisciplinary science methodology and necessity of embracing it for all scientific researches. The endogenization of set optimal solutions of current and future persistent and complex problems lie within the domain of transdisciplinary approach.

### References:

American Academy of Art and Sciences. "Transdisciplinary Opportunities." *ARISE 2: Advancing Research in Science and Engineering: Unleashing America's Research & Innovation Enterprise*. Cambridge: American Academy of Art and Sciences, 2013. 14. Print.

- Chestshire, Stuart. "Collected Quotes from Albert Einstein." Collected Quotes from Albert Einstein. Web. 30 Oct. 2014. <<http://rescomp.stanford.edu/~cheshire/EinsteinQuotes.html>>.
- Güvenen, O. "Economic Prosperity, Interaction with Science, Knowledge and Value Systems" in Statistics, Science and Public Policy XII, ed. A.M. Herzberg. (2008) Kingston: Queen's University, p. 49, ISBN: 978-1-55339-152-4
- Güvenen, O. "The Interaction Between Econometrics, Information Systems and Statistical Infrastructure: Anticipation and Comparative Analysis in a Decisional Structure". (2000) Journal of the Turkish Statistical Association.Vol. 3, Nr. 1-2. Ankara, pp. 22-43.also(Non-published paper presented at the University of Europe Conference, Aix-en-Provence, 1971)
- Güvenen, O. "Nanotechnology Informatics and New Economic Paradigms – A Transdisciplinarity Approach".(2010). 100th International Conference of Applied Econometrics Association.Bilkent University. Ankara, Turkey
- Güvenen, O., M.H. Öztürk. "Transdisciplinarity In Decision Sciences: A Discourse On Polymath Methodology " presented at the Institute of Operations Research and the Management Sciences – INFORMS. (2008)Washington D.C.
- Güvenen, O., "Eğitim, Bilim, Teknoloji Vizyonu", Türkiye'nin 2023 Eğitim Vizyonu, Özel Okullar Birliği. (2009).s. 53-65, ISBN: 978-975-00250-1-3, İstanbul. (PowerPoint presentation)
- Hadorn, G.H., Hoffman-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., and Zemp, E. (Eds) (2008) Handbook of Transdisciplinary Research. Springer.
- Rosenfield, Patricia L. "The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences."Social science & medicine 35.11 (1992): 1343-1357.