From dualism to complementarity: a systemic concept for the research process

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Abstract: In this paper, dualistic concepts are identified as limitations to scientific progress. A proposal is made for bridging a set of three gaps between polar opposites in order to pave the way towards a more holistic, systemic research practice. The dualistic concepts addressed are *explanation* vs. *understanding*, *exploration* vs. *hypothesis testing*, and *discovery* vs. *design*. If one treats these pairs of concepts not as dichotomies but as complementarities, then a synthesis of the concepts is accomplished. Through the use of directed graph notation, a dynamic view of the research activity emerges, which sheds new light on the process of innovation.

Keywords: research process; complementarity; systems science.

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1 Introduction

As stated above, the purpose of this paper is to make a contribution to a more holistic research practice. Science seems to be going from strength to strength if we judge by the number of researchers, institutes and the size of the funds available. But science is also in crisis, as can be seen from its fragmentation and incapacity to solve the intractable problems of our time (Husserl, 1962; Luhmann, 1990; Chargaft, 1992). To put it differently, science is society's organ of perception. It is the subsystem by which a society becomes aware of new, exceptional or challenging developments, so that it can respond to them. The crisis of modern society is – or has been claimed to be – a crisis of perception, more than anything else (Capra, 1982). Perception has tended to evolve from a holistic mode, which accounted for interconnections, towards a fragmented mode.

The scientific community has not remained oblivious to these difficulties: The call for interdisciplinary and transdisciplinary research is persistent, and it can hardly be ignored. Even so, research institutions find it hard to reorganise themselves along the lines of inter- or transdisciplinarity.

Interdisciplinary initiatives exist, but they are rare.¹ To an even greater extent than institutional bureaucratic hindrances, it is volitional barriers which are proving to be almost insurmountable. Scientists and science managers are for the most part reluctant to link up with researchers in other fields, either because they find it difficult or because they simply do not see any need for it.

Much of this situation is due to how the 'craft' of modern science is understood by researchers. This understanding is characterised by dualistic concepts which establish mutually exclusive polar opposites.

In this paper, a set of such dichotomies will be identified. Thereupon, a proposal will be elaborated on how to overcome them. A path towards a more holistic research practice should thus be opened up.

The argument propounded here relates essentially to the social sciences, not to science in general. It must be said in advance that the categories used in this paper are broad. They are much debated in the literature, as generally there is no consensus on pertinent concepts. Therefore, distinctions are not always as clear-cut as they might appear in this text, owing to necessary abstractions. We shall at least avoid dogmatic positions and concentrate on tendencies or propensities.

2 From dualism to complementarity

Here, only three examples of these dualistic concepts will be outlined, with reference mainly to social science in order to remain concrete:

- *The dualism of explanation and understanding*

Contrasting definitions of *explain* and *understand* stem from philosophy (Lenk, 1972; Apel, 2001); this contrast is generally used in the theory of social science. Explanation rests on the argumentative reference to known phenomena. Understanding denotes the comprehension of interdependencies between things, people and thoughts (Meyer, 1979, p.518). According to certain authors, the natural and the social sciences are fundamentally distinct from each other, and this difference is marked by the distinction between explanation and understanding (Moon, 1977). However, in principle there is no dichotomy between the two. Both explanation and understanding are needed in the social sciences (von Wright, 1971; Weber, 1964, p.88).

Depending on whether a researcher aims at explaining or understanding phenomena, he or she will have to resort to completely different research designs. In the first case, there will be a tendency to use objectivistic approaches, whereas in the second subjectivistic approaches will be preferred. Traditionally, the former have been associated with quantitative methods, surveys, sophisticated measurements and data analyses and the latter with qualitative techniques, e.g., ethnography, explorative interviews and hermeneutic methods. Explanation is – not only, but to a great extent – analytically

oriented, while understanding calls for synthesis. Keeping them separate leads to an explanation which is sterile and to an understanding which is shallow.

- *The dualism of exploration and hypothesis testing*

In seminars on research methods, one of the first things taught to students is usually that a researcher must decide early on whether he or she will take up explorative research or hypothesis testing. The former option then tends to be linked to qualitative research by means of examples, case studies, grounded theory building and the like. The latter will usually require relatively large scale quantitative research and statistical analysis. Separating the two, however, entails exploratory studies which remain inconclusive and leads to hypotheses which are narrow.

- *The dualism of discovery and design*

This dualism is very much visible in the distinction between basic and applied research. The former is considered disinterested in its efforts and value-free in its choice of subjects, being dedicated exclusively to the generation of pure knowledge for its own sake. The latter is conceived of as a value-laden activity which transforms the pure knowledge derived from basic research into technical products or other tangible benefits (such as recommendations to agents in organisation and society).

The dualistic approach has been most prolific in the natural sciences and technology. At least in the social sciences, discovery remains pointless if it is detached from the purpose of design. And design becomes enfeebled or obsolete if it is not constantly nourished by discovery. Dichotomies such as those outlined above impose limitations on research, which ultimately obstruct scientific progress.

In the following, a conceptual proposal will be made which shows how the yawning gap between these polar opposites can be spanned. This proposal is conceptual in the sense that it concentrates on the logical relationships between the concepts and the way they are linked in the research process. The first step is to recognise that the relationship between each pair of concepts is not one of opposition but of complementarity. We herewith refocus our perspective on the research process. We recognise that researchers should strive for the integration of all these aspects, at least in their ‘wildest dreams’:

- explain and understand
- explore and test
- discover and design.

3 A concrete proposal

How can one draw up a holistic concept for research if one faces three (or more) kinds of dualism, as outlined above?

One could – as is often the case – take all six terms and draw a circle around them, signifying: “All of this must be taken into consideration”, with the addendum “... in a holistic way”.

To make progress here, i.e., to make a proposal which has implications for concrete research designs or projects, a more operational approach must be adopted. In this section, it will be shown, firstly, that the different terms introduced above with their different polarities do indeed relate to each other. Based on a readjusted, complementarity-oriented view, the terms can now be associated with specific levels of description and synthesised as components of one and the same picture. Secondly, a process-oriented view will be taken, which helps one to sort out the essential relationships among the six components.

The six terms – explanation, understanding, exploration, testing, discovery and design – cover a broad range of aspects of the research process. The following attempt to synthesise these partial aspects goes beyond the transformation of pairs of concepts from opposites into complements. It puts all three pairs of concepts into a larger, more comprehensive perspective.

To begin with, the six concepts are associated with different levels of description:

- *Discovery* and *design* are terms strongly related to the *ontological level*, because they classify objects. Also, discovery deals with the realm transcending sensory perception and design concerns creating new realities. Ontology (from Greek *ontos* – being and *logos* – word, reason) is about the nature of the reality investigated or constructed by a researcher.
- *Explanation* and *understanding*² are concepts which essentially belong to the *epistemological level*. Epistemology (from Greek *episteme* – knowledge, science) is about the relationship between the researcher and the object of his or her inquiry.
- *Exploration* and *testing* are concepts mainly associated with the *methodological level*. Methodology (from Greek *meta* – towards and *hodos* – path) concerns itself with the repertory of techniques, procedures and instruments used in the research process.

Accordingly, three different aspects can be combined into one all-embracing picture (Figure 1).

Figure 1 Levels of description of a research process

It would be facile to link everything with everything here, as is often done in schemes of this type. However, it is more desirable and rewarding to make an attempt at filtering out the essential relationships between the components. The result of such an attempt is presented in Figure 2. To achieve this result, a combination of deduction and induction was used. Firstly, the concepts were defined and put in a logical order. Secondly, the relationships between the concepts were reduced from a fully connected graph to a limited set of relationships. The procedure was governed by the principle of exclusion, so that less important linkages were successively eliminated. Importance here was defined in terms of likelihood of occurrence and significance. These were established as a function of rough estimates.

Figure 2 Components and relationships of a research process

It need not be especially emphasised that the relationships depicted here are by no means the only ones which may exist. They are merely considered to be those essential for the maintenance of a holistic research process. We shall now proceed to elaborate on each of these relationships. For this purpose, they have been numbered from 1 to 10 (Figure 3).

Figure 3 Sequence of the description

The starting point is exploration. We could also have chosen another component to start with, because the system is circular, being made up of closed loops.

Explore: Exploration is a penetration of an unknown domain, impelled by the desire to know – perhaps the most enduring of all the characteristics that distinguish *homo sapiens* from other species (Durant and Dooling, 1991). The purpose of exploration is discovery. The term carries a connotation of adventurous or entrepreneurial activity. If the purpose of exploration is discovery, then, though not invariably, discovery is the result (arrow 1).

Exploratory research is traditionally linked to the purpose of understanding the phenomena under study. Normally, the exploratory approach is chosen when little or nothing is known about the subject matter. However, exploration has an aspect of application, which fosters understanding (arrow 2).

Discover: To discover is to obtain a sighting or knowledge of something for the first time. The term evokes the sensation of the removal of a veil from something that is already there, whether actually or virtually. Breakthroughs in science and technology stem from discoveries. These may be the product of momentary inspiration or of a longer incubation or maturation period (Nickles, 2000). Discovery results from playful exploration (arrow 1) or systematic testing (arrow 3). In addition, design can be a further source of discoveries, as will be shown later. Discoveries on their part enable and trigger new designs (arrow 4).

Understand: To understand is more than just to know. It also includes a comprehension of the nature or meaning of the phenomena of interest. From the hermeneutical viewpoint, it entails recognising something ‘internal’ resulting from ‘external’ sensory inputs (Dilthey, 1957, p.318). Understanding, therefore, implies sense-making, interpretation, insight into the intentions of an actor or the signification of, e.g., a symbol, a social institution or a rite (von Wright, 1971). Therewith, the act of understanding transcends the objectively ascertainable. At the most elementary level, one can understand a linguistic or non-linguistic action by describing it as the actualisation of a scheme, as compliance with a rule, or the pursuit of a goal or an intention. At a deeper level, however, the task of understanding involves the comprehension of whole interrelations or textures (Meyer, 1979, p.518). In this way, the general meaning of single actions, objects or incidents can be construed.

Design or at least *good* design, must be nourished by deep understanding, i.e., insight into the nature of the object dealt with and the context in which it is embedded (arrow 5).

Design: By design we understand the act of working out the form of something. A design, then, is

“a plan or scheme conceived in the mind and intended for subsequent execution; the preliminary conception of an idea that is to be carried into effect by action.” (Simpson and Weiner, 1989, Vol. 4, p.519)

If the purpose of research is to contribute to the progress of society and the human condition in general, then it must abide by what could be called the design imperative: To assume the responsibility for making proposals for improved approaches, policies, rules, products, etc. In Figure 3 design is shown as having two further links, one to exploration, the other to testing. The link to Explore (arrow 6) closes the loop formed by arrows 2, 5 and 6. This sequence represents the design process, by which a design is

applied and therewith submitted to (further) exploration. Exploration in the application context gradually enhances understanding, which is fed back into the design itself, leading to adaptation and improvement. The link to Test (arrow 7), on the other hand, closes the loop formed by the arrows 7–9, which will be commented upon shortly.

Test: Testing is about examining something by means of a set of criteria. A test is a trial by which something's existence, quality or authenticity is determined. In science, testing involves the examination of the validity of hypotheses by means of parametric or non-parametric tests. These tests are of crucial importance for the examination of any outcome of the research process. Additionally, however, they are at the core of validation, i.e., the quest for ever better models of reality (Barlas and Carpenter, 1990). On the other hand, submitting products of any kind – tangible or intangible – to testing procedures is a routine for ensuring the quality or fitness-to-purpose of the products.

The arrow leading to Test emanates from Design (arrow 7). It represents the process by which design outcomes are submitted to tests. This link symbolises a process by which products of design are examined critically as to their quality, reliability or validity. That process constitutes a kind of triangulation for determining whether what is designed matches what is needed or required.

Explain: Explanation is the counterpart of understanding in the pair of concepts used at the outset. In today's science industry, most resources are dedicated to explaining phenomena. Explanation can be causal (by causes)³ or teleological, with respect to aims (by goals, i.e., intentions).⁴ To *explain* is derived from the Latin verb *explanare* – to describe clearly (metaphorically derived from the meaning of to flatten – from *planus* – flat). Accordingly, to explain means to unfold a matter, to give details of a matter or to make it intelligible (Simpson and Weiner, 1989, Vol. 5, p.569).

Explaining, therefore, is essentially a detail-oriented, sequential, analytical task, as opposed to understanding, which is synthetic, holistic and simultaneous. Also, in explanation the rational element dominates, while understanding is strongly reliant upon intuition. If explanation does not remain strictly analytical but opens itself to synthesis, then understanding is enhanced (arrow 10). Pragmatically speaking, “a good explanation increases our understanding of the world”. (Newton-Smith, 2000, p.130).

The link from Test to Explain (arrow 8) represents the process by which hypothesis testing gradually enables explanation. This is a process of building up confidence. Usually it also leads to more detailed knowledge. It rarely leads directly, however, to new discoveries. What *can* lead to discoveries, besides the process symbolised by arrow 1 originating from Explore, are serendipitous effects resulting from design activities (arrows 6 and 1) or from the process of testing (arrow 3).

The counterpart of arrow 8 is arrow 9, closing the loop 7-8-9 from Testing to Explaining to Design. It signifies the improvement of Design through gradual accumulation of (detailed) knowledge. This can be achieved through a sequence of changes in design, tests and the interpretation of test results leading to explanation, which again feeds into design. As mentioned earlier, the diagram (Figures 2 and 3) is a simplification. In addition to the relationships represented by the arrows, other links are possible. For example:

- *Understand* → *Explain*. Understanding has been declared to be a ‘method’ with the help of which human behaviour can be explained (Abel, 1948).
- *Discover* → *Explore*. Whenever a new ‘territory’ is discovered, the discoverers move in to explore it and make new discoveries. This is a recursive process.
- *Test* → *Discover*. Testing a hypothesis may lead to the discovery of a new phenomenon (for examples concerning experimental tests leading to discoveries, see Popper (2002, p.73).
- *Design* → *Understand*. The practice of design tends to enhance the understanding of the designer.

There are several closed loops in the diagram, e.g.,

- 9-6-1-4-7-8
- 5-7-8-10.

Here, we shall concentrate on four loops which are of especial interest:

- 2-5-6
- 7-8-9
- 4-7-3
- 4-6-1.

The first two relate to the question of how change can be brought about through research. To be precise, they refer to the question of how research can lead to improved design, to the ultimate benefit of society and humanity as a whole. This is very much about how knowledge is created.

In order to make a comparison of the two approaches to design improvement which figure in our diagram, two ideal types can be described in detail: The 2-5-6-loop represents an approach to improvement which may be rather unsystematic, often playful, and riddled with uncertainty. The 7-8-9-loop, on the other hand, is more systematic, more linear, and not so much fraught with uncertainty. Both, however, are subject to trial-and-error.

The two cycles essentially denote two different modes of knowledge creation. We call the first one *interpretative* (or *hermeneutic*) and the second one *positivistic*, in order to capture their characteristics in a condensed way. The terms *ratiocinative loop* vs. *intuitive loop* would also be an acceptable, pragmatic approximation. The two cycles are self-reinforcing.

In the case of the *positivistic loop* (7-8-9), testing enables explanation, which supports design, which gives rise to new tests. This is the domain of ‘external rationality’ (Husserl, 1962) and empiricism in search of the ‘objective truth’. The denomination of this loop derives from its focus, which is on the evidence-based capturing and analysis of real-world features and relationships. These are used to improve the object of design. Progress tends to be incremental, with little risk.

As far as the *hermeneutic loop* (2-5-6) is concerned, exploration enhances understanding, which improves design, which triggers more exploration. This is the domain of ‘immanent reason’, which operates at a deeper level than external rationality (Husserl, 1962) and breeds insight, thereby shaping reality. The denomination of the loop is due to its focus on a more holistic, exploration-based interpretation of the world. The approach is one of synthesis rather than analysis. Improvements in design tend to be based on intuitive insights. The potential is for strong and sudden progress, but potential risk is also higher.

The two circles described are virtuous to the extent that they leverage the complementarities discussed in this paper, first and foremost the complementarity of explanation and understanding.⁵ It is problematic to attempt to reconcile an interpretative with a positivistic view. A full integration – e.g., via compromises or dubious medleys of methods⁶ – is neither advocated here nor possible. What is proposed is an enhancement of the dialogue between the two perspectives for their mutual benefit.

The other two loops are complementary to the first two. Both are about innovation, addressing the question how novelty comes about, more exactly what triggers discovery and (good) design. Loop 4-7-3 two departs from a pattern of systematic activity. We therefore label it the cycle of *systematic innovation*. Tests are routinely carried out, but over time serendipitous effects may occur and lead to discovery. A well-known case in point is Sir Alexander Fleming’s discovery of penicillin, which was induced by an accidental impurity in his staphylococcus cultures by a mould fungus. In the social sciences, a good example is the Hawthorne Experiments by Elton Mayo. These were intended to study the effects of monotony and fatigue on worker productivity. In the process, Mayo stumbled on the phenomenon of human motivation, which then had a profound impact on both the theory and practice of management.

Loop 4-6-1, then, departs from a pattern of behaviour which is of a more intuitive nature. Conclusively we call it the cycle of *intuitive innovation*. Exploration proceeds as if it were random. This randomness is only partial because explorers try out what they find promising or at least interesting. Eventually a discovery may happen. A famous example about an innovation along this path is Guglielmo Marconi’s achievement of the first wireless radio transmission. Intuitively Marconi stuck to his belief in the possibility of wireless transmission even though his endeavour defied the existing theories, until his indefatigable experimentation bred success. An example from the social sciences is Anatol Rapoport’s work in game theory. His hunch that despite the dominant tenet of the rational actor exclusively oriented by self-interest, together with his insights from earlier biological models that cooperation breeds a dividend, led to extensive experiments. These resulted in revolutionary findings which were embodied, e.g., in his ‘tit-for-tat’ strategy.

It is obvious that the innovation processes which here have been called *systematic* and *intuitive* can not be separated with total tidiness. In practice an innovation always emanates from a combination of the two components. What varies, however, are their relative weights.

As a résumé of these deliberations, our initial scheme is finally presented in a way so as to particularly highlight the four loops discussed here (Figure 4).

Neither the relationships between the concepts nor those between the loops are of a dialectical nature, which would imply a progress from thesis to antithesis and towards a synthesis in the sense of emerging new concepts. Instead, the relationships shown represent the interplay of complementary concepts, which together embody the process of innovation.

So much, then, for the links and activities, which make up the research process. The systemic features of this representation, among others, are that it is integrative, relational, dynamic and holistic. It is integrative in the sense that the components of different levels of description are synthesised. It is relational because these components are linked to one another. It is dynamic insofar as sequences and circular processes are identified and explained. Finally, it is holistic in the sense that the emphasis falls on the research process as a whole, not on partial aspects.

Figure 4 The initial scheme with four crucial loops

One could, no doubt, expand the scheme outlined here by drawing a boundary between the process and its environment. One could also, on a higher level, visualise aspects such as worldview, values, ethics and aesthetics, all of which impinge on the research process. As elaborating on these would be beyond the scope of this paper, however, we refrain from simply adding another graph, preferring to limit ourselves to this *pro memoria*.

4 Conclusions

This paper is an attempt to conceptualise the research process systemically. It commenced with a set of dualistic concepts on which modern science operates. The essential proposal here is that the dualistic view should be abandoned in favour of a complementaristic approach. This means that partial aspects of the research process, e.g., explanation and understanding, hitherto regarded as mutually exclusive opposites, should rather be considered complementary, completing and perfecting each other.

In a step-by-step approach, the concept pairs making up different levels of description of the research process have been linked together, with an emphasis on essential relationships. This resulted in a fuller picture of any research process. In its idealised form, it shows a path towards a more systemic approach to research which is less reductionist as well as more open and conducive to inter- and transdisciplinary modes of operation.

A limitation of this approach is that not all possible relationships have been made explicit, which would go far beyond the scope of this paper. This limitation, however, is also an opportunity to get at essential dynamics. An exploration of other links and loops might lead to finding other things.

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Notes

¹For example, *Management Science*, one of the leading research journals, created a section on interdisciplinary studies a few years ago, which was closed soon afterwards for lack of interest by potential authors.

²We use the term *explanation* here with a positivistic connotation, while the term *understanding* is used with a hermeneutic, interpretative connotation, as in the sociological movement called *verstehende Soziologie* (Weber, 1982). Positivism is an epistemological position which makes *the positive*, i.e., the given or factual, the principle of all scientific knowledge. Hermeneutics on the other hand is an epistemological position, the ideal and the methods of which are directed towards knowledge-generation by means of interpretation and understanding. For details, see Seiffert and Radnitzky (1994).

³From a rigorous stance, statistical explanations can never ‘prove’ causality definitely, but only answer ‘why’-questions.

⁴For a differentiated view of causality, see Aristotle’s (1999) four kinds of causality, material cause (*causa materialis*), formal cause (*causa formalis*), moving cause (*causa efficiens*) and the final cause (*causa finalis*). There, teleological explanation is subsumed under causal explanation. See also the discussion of causal vs. non-causal explanation in Ruben (1990).

⁵Not only are processes of joint learning possible. Such complementarity can be leveraged effectively by alternating phases in which hermeneutical methods and others in which positivistic approaches are applied.

⁶Not all combinations of different methods are dubious, and some are even very much needed (Schwaninger, 2004).