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SCIENTIFIC METHOD

The scientific method is a set of assumptions and procedures for knowledge acquisition consistent with scientific norms. Such a definition emphasizes three elements of the scientific method: (1) assumptions, (2) procedures, and (3) consistency. Awareness of these three elements is a prerequisite for research in general and case study research in particular. The following section thus discusses scientific assumptions regarding ontology, epistemology, and methodology.

Conceptual Overview and Discussion

Knowledge acquisition implies the generation, development, and testing of theory. Generation and development of theory may occur without data. In particular, intuitive or theoretical syntheses without the consideration of data may generate and develop constructs, models, and testable propositions. Theory-testing, however, requires data in order to confirm or disconfirm testable propositions.

Knowledge, on the other hand, has various degrees of depth and breadth. Knowledge depth increases with identification, description, explanation, prediction, and control. Such sequential degrees of knowledge depth are implicit, respectively, in "what," "how," "why," "when," and "how much" questions. *Knowledge depth* refers to content and process, whereas *knowledge breadth* concerns context, which is implicit in "who" and "where" questions. The corollary of such a view of knowledge depth and breadth is that qualitative identification necessarily precedes quantitative control.

Such considerations are closely related to the scientific method because the latter constitutes a metalogic for bridging theory and data. In other words, the scientific method is a set of assumptions and procedures for knowledge acquisition consistent with scientific norms. Such a definition emphasizes the three elements of the scientific method listed at the beginning of this entry, that is, (1) assumptions, (2) procedures, and (3) consistency.

Consistency concerns the alignment of assumptions and procedures in light of scientific norms. The latter, however, are not necessarily universal, because of logical and sociological heterogeneity. Philosophy of science, for instance, questions the compatibility between different types of logic (e.g., deduction, induction, abduction, and retroduction), especially in terms of causality as necessarily observable, regular, and predictable. Sociology of science, on the other hand, questions the homogeneity of scientific norms across disciplinary and intradisciplinary research communities.

The definition of *scientific method* can thus be specified as a set of assumptions and procedures for knowledge acquisition that are consistent with (logically and sociologically situated) scientific norms. In addition to such logical and sociological awareness, research in general, and case study research in particular, requires awareness of scientific method assumptions and procedures. *Assumptions* concern the nature of reality (ontology), knowledge (epistemology), and research

(methodology). *Procedures,* on the other hand, concern data collection and analysis as well as quality criteria.

Ontological assumptions concern the nature of reality. At one extreme, phenomena are regarded as objective in isolation and in relation to each other; at the other extreme, phenomena are considered subjective in isolation and in relation to each other. The former view assumes a single apprehensible reality, whereas the latter view assumes the coexistence of multiple nonapprehensible realities. This may be called the *ontological divide* of scientific norms.

Epistemological assumptions, on the other hand, concern the nature of knowledge. At one extreme, knowledge is assumed to be value free and thus independent of the researcher; at the other extreme, knowledge is assumed to the value laden and thus dependent on the researcher. This may be called the *epistemological divide* of scientific norms.

Finally, *methodological assumptions* concern the nature of research. At one extreme, research is regarded as manipulative in the sense that it benefits from distance to reality; at the other extreme, research is assumed to be interactive in the sense that it benefits from proximity to reality. This may be called the *methodological divide* of scientific norms.

When aligned, ontological, epistemological, and methodological assumptions constitute a philosophical stance, that is, a fixed profile of positions in terms of ontology and epistemology. Such a profile may be labeled, among others, as a *paradigm, position, orientation, approach,* and *perspective.* Because assumptions are unavoidable in human reasoning but are not necessarily conscious, researchers may inadvertently lack awareness of their own philosophical stance. The ontological, epistemological, and methodological divide of scientific norms has thus been elaborated into four main philosophical stances: (1) positivism, (2) realism, (3) critical theory, and (4) constructivism.

When facts are researched in isolation from their context, the implicit philosophical stance is *positivism.* Such isolation of facts from their context is due to the emphasis on measurement through many statistical sampling units and few analytical variables (in form of testable propositions). By contrast, when facts are researched in

relation to their context, the implicit philosophical stance is *realism.* Instead of measurement, the emphasis is on synthesis through many analytical variables and few statistical sampling units.

On the other hand, when values are researched in relation to their context, the implicit philosophical stance is *critical theory.* Instead of measurement or synthesis, the emphasis is on observation of collective rather than individual values. By contrast, when values are researched in isolation from their context the implicit philosophical stance is *constructivism.* Instead of measurement, synthesis, or observation, the emphasis is on interaction in order to identify individual rather than collective values.

The assumptions implicit in positivism, realism, critical theory, and constructivism require, therefore, measurement, synthesis, observation, and interaction skills, respectively. Such skills are aligned with the continuum of methodological assumptions from manipulative to interactive research. Moreover, such skills and assumptions may be aligned with procedures for data collection and analysis as well as quality criteria. The overall set of such procedures constitutes a *research strategy.*

Application

Research strategies are dilemmatic by nature; in other words, they are unable to maximize simultaneously analytical and statistical generalization. Statistical generalization requires many sampling units and few analytical variables. Analytical generalization, by contrast, requires many analytical variables and few statistical sampling units. On the other hand, the very notion of generalization or external validity is debatable as a criterion of scientific quality. In fact, objectivist philosophical stances such as positivism and realism imply validity and reliability criteria, namely through triangulation. By contrast, subjectivist philosophical stances such as critical theory and constructivism assume that values are not prone to triangulation as facts, replacing triangulation with crystallization as a means for trustworthiness and authenticity criteria instead of objectivist validity and reliability criteria.

Quantitative research strategies are exclusively aligned with the positivist philosophical stance because they seek the measurement of facts in

isolation of their context. Case study research, by contrast, is a rather versatile qualitative research technique because it may be aligned with any philosophical stance.

Within the positivism philosophical stance, case study research allows the exploration of facts ahead of their measurement. Given the emphasis of positivism on statistical generalization, case study research is regarded as having low external validity. Within the realist philosophical stance, however, case study research is regarded as having high external validity, because the emphasis is on synthesis rather than measurement and on analytical rather than statistical generalization.

On the other hand, within the constructivist philosophical stance case study research is suitable for collecting and analyzing data on individual values. Although such individual values are regarded in isolation from their context, case study research is an appropriate strategy, because the cases may be individuals. The quality criteria for judging the validity and reliability of findings may, however, be replaced by subjectivist criteria such as trustworthiness and authenticity.

Finally, within the critical theory philosophical stance case study research is appropriate for collection and analysis of data on social values. Such values are regarded in relation to their context in terms of time and space, implying longitudinal and cross-sectional cases at a level of analysis higher than the individual level. The quality criteria for judging the validity and reliability of findings may equally be subjectivist criteria, such as trustworthiness and authenticity.

Critical Summary

The scientific method is a set of assumptions and procedures for knowledge acquisition that are consistent with scientific norms. Ontological, epistemological, and methodological assumptions may be clustered in four main philosophical stances: (1) positivism, (2) realism, (3) critical theory, and (4) constructivism. Case study research is a versatile research strategy, because it can be aligned with these four stances. Researchers need to be aware, however, that these philosophical assumptions differ in terms of their focus on facts or values, in isolation or in

relation to their context. As a result, case study procedures for data collection and analysis as well as quality criteria equally differ. In particular, statistical generalization of factual measurement may be complemented with analytical generalization of factual synthesis, factual triangulation may be replaced with value crystallization, and factual validity and reliability criteria may be replaced with value trustworthiness and authenticity criteria.

Ricardo Alexandre Morais

See also Abduction; Analytic Generalization; Epistemology; Inductivism; Ontology

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SCIENTIFIC REALISM

Scientific realism is the view that science enables us to know and understand the way the world really is. It is closely related to (logical) positivism.