

Science: Introduction

For Science

There is something special about science and its methods.

Science is held in high regard.

Ads assert that a particular product has been scientifically shown to have certain characteristics (more potent, whither, more sexually appealing than its rival products).

Science is essentially a problem solving activity.

Against Science

Science has no special features that render it intrinsically superior to other kinds of knowledge such as ancient myths or voodoo.

A high regard for science is seen as a modern religion, playing a similar role to that of Christianity in Europe in earlier eras.

Choices between scientific theories boil down to choices determined by the subjective values and wishes of individuals.

Origins of modern science

Modern science was born in the early 17th century when the observation of facts became the basis for science.

Before that knowledge was based on authority, e.g., the Bible or Aristotle.

Two schools of thought: Knowledge should be derived from the facts of experience arrived at by observation

Empiricists (David Hume, John Locke).

Positivists (Vienna Circle 1920's)

Modern Science: Bacon (1561-1626)

Bacon proposed inductive logic to replace Aristotelian methods (deductive logic) and gave a much more central role to experience and experiments.

Bacon's method rests on two pillars:

Observation.

Induction.

Observation is supposed to be undertaken without prejudice or preconception, and we are to record the results of the data of sensory experience, what we can see, hear, and smell, whether of the world as we find it, or of the special circumstances of our experiments.

The results of observation are expressed in what are called **observation statements**. Once we have made a whole host of observations these are to be used as the basis for scientific laws and theories. Many scientific laws are of the form of what are called universal generalisations; these are statements that generalise about the properties of all things of a certain kind.

Observations must be free from the influence of the first three Idols.

The composition of a Natural and Experimental History. The idea is to reach the truth by gathering a mass of information about particular states of affairs and building from them step by step to reach a general conclusion.

Experiments are important because if we simply observe what happens around us we are limited in the data we can gather; when we perform an experiment we control the conditions of observation as far as is possible and manipulate the conditions of the experiment to see what happens in circumstances that may never happen otherwise. Experiments allow us to ask ‘what would happen if . . .?’.

Repeatable experiments. Experiments have to be repeatable so that others can check the results obtained. Data must be included in tables of various kinds.

The Idols of the Mind (analogous to fallacies of reasoning in deductive logic).

The tendency of all human beings to perceive more order and regularity in nature than there is in reality.

The Idols of the Cave are individual weaknesses in reasoning due to particular personalities and likes and dislikes.

The Idols of the Marketplace are the confusions engendered by our received language and terminology, which may be inappropriate yet which condition our thinking.

The Idols of the Theatre are the philosophical systems that incorporate mistaken methods, such as Aristotle’s, for acquiring knowledge.

Induction.

It is the form of reasoning where we generalise from a whole collection of particular instances to a general conclusion.

This involves studying all the information displayed in the tables and finding something that is present in all instances of the phenomenon in question, and absent when the phenomenon is absent, and furthermore, which increases and decreases in amount in proportion with the increases and decrease of the phenomenon. The thing that satisfies these conditions is to be found by elimination and not by merely guessing.

The forms of things. Science must discover the forms of things, i.e., the immediate causes or the general principles or laws that govern phenomena in the material world

Science: Empiricism and Positivism **Traditional notion of science**

Science knowledge derived from the facts of experience through observation.

Not derived from personal opinion.

It is a rational activity operating according to some special method.

Elements of science

Facts (know through observation)

Logical reasoning (derived from facts)

Facts

Facts are presumed to be claims about the world that can be directly established by a careful, unprejudiced use of the senses.

Science is to be based on what we can see, hear, and touch rather than on personal opinions or speculative imaginings.

Assumptions

Facts are directly given to careful, unprejudiced observers via the senses.

Facts are prior to and independent of theory.

Facts constitute a firm and reliable foundation for scientific knowledge.

Facts

Two individuals can see the same thing but interpret what they see differently.

One person can see something different at different times.

Observable facts are expressed as statements.

Observation statements are not given to observers via the senses.

Theory precedes facts. Facts do not precede theory.

We need a theory to be able to observe (e.g., child naming an apple).

Perceptions are influenced by the background and expectations of the observer.

What appears to be an observable fact for one need not be for another.

Judgments about the truth of observation statements depend on what is already known or assumed, thus rendering the observable facts as fallible as the presuppositions underlying them.

Deriving theories from facts Inductivism or induction

Inductivism in its most crude and naive form says we can generalize from a collection of observations to a general conclusion.

When we observe a large number of Xs under a wide variety of conditions, and when all observed Xs have been found to cause Y, then naive inductivism says that it's logically valid to say that *all* Xs cause Y.

Example: Every book on science has more than 300 pages in a random sample of 200 books. This strongly supports the following conclusion: All books on science have more than 300 pages.

Critique of induction Conditions

- The number of observations forming the basis of generalizations must be large.
 - o Large is a very vague concept.
- The observations must be repeated under a wide variety of conditions.

- o Each inductive argument involves an appeal to prior knowledge, which needs an inductive argument to justify it, which involves an appeal to further prior knowledge and so on in a never-ending chain.
 - No accepted observation statement should conflict with the derived law.
- Other problems.
 Much of knowledge refers to the unobservable.

Other problems

Much of knowledge refers to the unobservable.

An attempt to justify induction by an appeal to experience involves assuming what one is trying to prove. It involves justifying induction by appealing to induction, which is not reasonable.

The principle of induction worked on occasion X1.

The principle of induction worked on occasion X2.

The principle of induction always works.

Explication of conceptions (Whewell)

There is a new element added to the combination of instances by the very act of thought (colligation) by which they were combined'

Colligation is the mental operation of bringing together a number of empirical facts by 'superinducing' upon them a conception which unites the facts and renders them capable of being expressed by a general law. The conception provides the 'true bond of unity by which the phenomena are held together', by providing a property shared by the known members of a class. This is important because the fundamental ideas and conceptions are provided by our minds, but they cannot be used in their innate form.

Explication of conceptions (Whewell)

The ideas are in the human mind before experience; but by the progress of scientific thought they are unfolded into clearness and distinctness. This 'unfolding' of ideas and conceptions as the 'explication of conceptions.' Explication is a necessary precondition to discovery, and it consists in a partly empirical, partly rational process.

Scientists first try to clarify and make explicit a conception in their minds, then attempt to apply it to the facts they have precisely examined, to determine whether the conception can colligate the facts into a law.

If not, the scientist uses this experience to attempt a further refinement of the conception. Whewell claimed that a large part of the history of science is the 'history of scientific ideas,' that is, the history of their explication and subsequent use as colligating concepts.

Deductive reasoning

All men are mortal.

Aristotle is a man.

Aristotle is mortal.

All dogs have five legs.
Tiffany is a dog.

Tiffany has five legs.

Deductive logic can yield to absurd results.

Deductive reasoning

Similarly, not all invalid arguments are intuitively bad arguments. For example:

Jimmy claims to be a philosopher.
I have no reason to believe he is lying.

Therefore Jimmy is a philosopher

This argument is persuasive but invalid.

Positivism: Falsifiability (Popper)

Science is a set of **falsifiable** hypotheses that are tentatively proposed with the aim of accurately describing or accounting for the behaviour of some aspect of the world or universe.

A hypothesis is falsifiable if there exists a logically possible observation statement of that is inconsistent with it.

The Falsification Principle, proposed by Karl Popper, is a way of demarcating science from **non-science**. It suggests that for a theory to be considered scientific it must be able to be tested and proven false. For example, the hypothesis that "all swans are white," can be falsified by observing a black swan.

Examples of statements that are falsifiable.

It never snows in summer. The Eiffel Tower is taller than the CN tower.

Examples of statements that are not falsifiable.

Either she is happy or unhappy. Luck is possible in a love relation.

Falsification is inadequate on historical grounds.

Khun and the Scientific Revolution

Khun: Paradigms

A mature science experiences alternating phases of normal science and revolutions. In normal science the key theories, instruments, values and metaphysical assumptions that comprise the

disciplinary matrix are kept fixed, permitting the cumulative generation of puzzle-solutions, whereas in a scientific revolution the disciplinary matrix undergoes revision, in order to permit the solution of the more serious anomalous puzzles that disturbed the preceding period of normal science.

Science assumes that there is only one truth about a given subject, for example that the laws of gravity are universal and do not change on Thursdays or when you are on Mars.

Science historian Thomas Kuhn described how a single truth or paradigm dominates a field of science at any one time, and that serious change in science occurs as one paradigm competes with (and overcomes) another. For example Newton's laws held sway for many years until they were shown not to apply in sub-atomic situations. Quantum physics arose as an explanation of what happens in these microscopic situations.

Pre-paradigmatic stage

In the pre-paradigmatic stage there is confusion as multiple paradigms are put forward by different schools of thought. Scientists may disagree vociferously with one another as they propose and support their individual theories.

Over time, as the ideas compete, scientists cluster around a small set of paradigms (often two), each trying to support their own ideas and destroy the opposing paradigms. Eventually, one paradigm wins through and becomes the dominant principle.

Normal science

Most science is 'normal science', in which scholars accept the dominant paradigm of the day, performing experiments that test and prove its efficacy in a range of situations. New explanations may extend the paradigm but do not change its fundamental nature.

In this way, the paradigm may grow with many extensions to explain the various exceptional cases that are not easily covered by the original paradigm.

Extraordinary science

Eventually a new paradigm is explored and proposed which challenges the existing paradigm. New methods may be used as new theories are proposed and proven. This work is outside of the canon of normal science and assumes that the dominant paradigm is probably not fully true in certain circumstances.

Concept of science

Notion of science

Influential authors (French epistemological tradition)

- Althusser
- Bachelard
- Bourdieu
- Kuhn
- Laudan
- Feyerabend

Notion of science

There is science when members of a disciplinary community, grouped around a common paradigm or a research tradition, recognize their disciplinary practice as scientific and are engaged in institutional social practices that members of other communities that also recognize themselves as scientific are engaged in, such as research, peer-reviewed publications in journals and books, participation in conferences, and university teaching, among others.

Thus, science –even the so called natural sciences- is a social construction; and scientific knowledge is epistemologically conquered, constructed, consented, and watched, which implies a break with respect to previous knowledge.

It may include the recognition of other scientific communities, which may be fulfilled with the recognition of some –but not necessarily all- scientific communities.

Science. Elements of its definition

- Disciplinary community.
- Common paradigm (Kuhn) or research tradition (Laudan).
- Recognition that the disciplinary practice is scientific by the members of the community of practice.
- Institutionalization of practices.
- Social practices similar to other scientific communities.
- Social practices: research, peer-reviewed publications, conferences, and university teaching.
- Social construction.
 - Knowledge is constructed, consented among members of the disciplinary community.
- Epistemological break (Bachelard).
- Epistemological watch (Bourdieu & Bachelard).
- May include social recognition by other scientific communities (Follari).

Feyerabend: Against Method Against Method (Paul Feyerabend)

Events, procedures, and results that constitute sciences have no common structure; there are no elements that occur in every scientific investigation but are missing elsewhere.

Science cannot be used as an argument for treating as yet unresolved problems in a standardized way.

Non-scientific procedures cannot be dismissed.

Sciences must be protected from ideologies. And societies, especially democratic societies, must be protected from science.

The profits of science should never be imposed. They should be examined and freely accepted by the parties of the exchange.

In a democracy, scientific institutions, research programs, and suggestions must be subjected to public control. There must be a separation of state and science just as there is separation between state and church.

Science should be taught as one view among many and not as the only road to truth and reality.

Science is an essentially anarchic enterprise: theoretical anarchism is more humanitarian and more likely to encourage progress than its law-and-order alternatives.

This is shown both by an examination of historical episodes and by an abstract analysis of the relation between idea and action. The only principle that does not inhibit progress is: anything goes.

For example, we may use hypotheses that contradict well-confirmed theories and/or well-established experimental results. We may advance science by proceeding counterinductively. The consistency condition which demands that new hypotheses agree with accepted theories is unreasonable because it preserves the older theory, and not the better theory. Hypotheses contradicting well-confirmed theories give us evidence that cannot be obtained in any other way. Proliferation of theories is beneficial for science, while uniformity impairs its critical power. Uniformity also endangers the free development of the individual.

There is no idea, however ancient and absurd, that is not capable of improving our knowledge. The whole history of thought is absorbed into science and is used for improving every single theory. Nor is political interference rejected. It may be needed to overcome the chauvinism of science that resists alternatives to the status quo.

No theory ever agrees with all the facts in its domain, yet it is not always the theory that is to blame. Facts are constituted by older ideologies, and a clash between facts and theories may be proof of progress. It is also a first step in our attempt to find the principles implicit in familiar observational notions.

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Irrational methods of support are needed. Modern science survived only because reason was frequently overruled in the past.

Neither science nor rationality are universal measures of excellence. They are particular traditions, unaware of their historical grounding.

Science is neither a single tradition, nor the best tradition there is, except for people who have become accustomed to its presence, its benefits and its disadvantages.

Research

Research is conceived of as a way of looking for a solution to a problem through a systematic process, which includes the production of valid and reliable information and requires the completion of certain stages so as to ensure that the solution to the problem is also valid.

Research problem

Science starts with problems, not with observation.

Problems are only problematic in light of some theory.

A research problem is a state of things, events, situations, or processes, whether theoretical or empirical, which are perceived as unsatisfactory or problematic.

If the solution to the problem is not obvious within the set of existing knowledge and techniques, the problem requires research.

Since problems do not exist in isolation, the selection and formulation of the problem presuppose some general experience and knowledge of the subject.

To formulate a problem, it is necessary to review the literature in the discipline, i.e., the theoretical and empirical knowledge produced on the subject in question.

The research problem must be preceded by a study of the literature and a mapping of what has already been discovered.

Research problem vs research question

Problem formulation may include a question, but not every question is a problem.

A research question defines and guides the conceptual field of the investigation.

But the research problem must still be clearly formulated as a statement, which may include a question at the end.

Research problem: Examples

The WHO and reputed epidemiologists recommended social distancing, the use of face masks, quarantines, and even complete lockdowns to deal with Covid-19.

Some countries that adopted these measures from the beginning of the Covid-19 pandemic had low infection and death rates.

However, other countries which implemented these same measures, had higher infection rates – even considerably higher than countries which had adopted none of the suggested measures.

How can the difference in infection and death rates be explained in countries that adopted the same WHO-recommended measures?

Examples of poor research problems.

There is no hospital in Wawa, so its residents must travel more than 300 km to access a hospital.

Is it possible to wear a face mask when playing soccer, basketball, and other team sports.

According to a recent poll, most citizens do not approve of the current federal government.

How to find a research problems

Many publications based on research projects include recommendations for future research.

You identify contradictions, anomalies in a theory.

A theory lacks elaboration.

A certain author generated some interesting results, but never followed up on those results.

You can review a successful theory, but disagree with the results, the tests used, or the methodology and retest the hypothesis.

A theory was tested in a certain historical or geographical context; and you may want to adapt it to another historical period or to another society.

The structure of a research problem: Laudan Empirical vs. conceptual problems.

Empirical problems are first-order about the substantive entities in some domain.

A conceptual problem is a problem exhibited by some theory. It is a higher order question about a well-foundedness of the conceptual structures, i.e., theories, which have been devised to answer first order questions.

Internal conceptual problems. When a theory exhibits certain internal inconsistencies, or when its basic categories of analysis are vague and unclear;

External conceptual problems. When a theory is in conflict with another theory or doctrine, which the former's proponents believe to be rationally well founded.

Internal conceptual problems. Laudan

A logically inconsistent theory, and thus self-contradictory.

Conceptual ambiguity or circularity within the theory.

Some degree of ambiguity is ineliminable.

Some small measure of ambiguity is positive, since less rigorously defined theories can often be more readily applied to new domains of investigation than rigid ones.

Systematic and chronic ambiguity or circularity within a theory is highly disadvantageous.

The explication of conceptions. The increase of the conceptual clarity of a theory through careful clarifications and specifications of meaning is one of the most important ways in which science progresses (William Whewell, 1840).

External conceptual problems. Laudan

Inconsistency. A logical inconsistency or incompatibility with another theory.

Implausibility. When there are two theories, even when compatible, and the acceptance of one of them makes less plausible that the other is acceptable.

Compatibility. When a theory emerges which ought to enforce another theory, but fails to do so and is merely compatible with it.

Interdisciplinary structure of science. At any given epoch, there are hierarchical systems of interconnection among the various sciences which condition the rational expectations which scientists have when they appraise theories.

External conceptual problems. Laudan Classes of difficulties which can generate external conceptual problems

Intra-scientific difficulties. Two scientific theories from different domains are in tension.

Methodology. A scientific theory is in conflict with the methodological theories of the relevant scientific community.

Worldview. A scientific theory is in conflict with any component of the prevalent worldview.

The structure of a research problem

- Internal inconsistency of the research object.
- Contradiction between two research objects.
- Lack of elaboration of a research object.
- Adequacy of a research object to higher-level research object.
- The effects or consequences of the research object.
- Erroneous application of a research object.
- Comparison and contrast between two research objects.
- The cause or origin of a research object.
- The development or evolution of a research object.
- The lack of sufficient information about the research object.
- The advantages and disadvantages of the research object.

Elements of a research problem

- The premise
 - Implicit or explicit.
 - The premise must be valid.
- The topic
 - The what of the research problem.
 - It is the research object, e.g., a theory, a social phenomenon, a norm such as a law or a legal principle.
- The temporal dimension of the problem.
 - When.
- The spatial dimension of the problem.
 - Where.
- The population or universe of the problem.
 - Who.

Strategies

The research problem makes it clear why it is a problem and why it is important to solve it. For example, it is not enough to say that the effects of quarantine on older adults will be investigated. It is necessary to explain why this is a problem and why it deserves to be investigated.

It is possible to obtain the necessary evidence to address the problem. For example, if you want to know the origin of a word in the Russian language and you don't speak Russian, it will be impossible to carry out this research.

The research problem is precise and clear. It does not use ambiguous terms that require definitions. It is formulated according to one of the valid structures of research problems.

The premises of the research problem are explicit and valid.

The research problem contains all the required elements.

Hypothesis

The hypothesis is a provisional or conjectural solution to the problem formulated as a declarative statement.

It includes, at least, two variables and, at least in a general sense, it had to be testable or verifiable.

The hypothesis must be based on the literature review and must be scientifically based, i.e., it must be compatible with the existing body of knowledge.

If the research problem included a research question, then the hypothesis is the answer to that question.

Hypothesis. Example

The population in countries that adopted WHO-recommended measures for dealing with Covid-19 and had higher infection and death rates than other countries that also adopted these measures, did not follow –or followed quite loosely- these WHO- recommended measures.

Hypothesis

The variables in a study of a cause-and-effect relationship are called the **independent and dependent variables**.

The **independent variable** is the **cause**. Its value is *independent* of other variables in the study. The **dependent variable** is the **effect**. Its value *depends* on changes in the independent variable.

Research objectives

The specific achievements that the researcher hopes to obtain in the study.

It summarizes what will be accomplished with the research.

General research objective has to be clear, concise, and declarative. It provides guidance for carrying out the project.

A clearly defined research objective helps the researcher focus on the study and determine the type of knowledge that will be produced.

A general objective can be broken down in several narrower specific objectives to facilitate the investigation.

Research objective

To analyze the cause for the disparity of infection and death rates between the countries that adopted the same measures to combat Covid-19 pandemic.

The general objective should not be too broad.

Before formulating the research objective, it is necessary to do the literature review.

The formulation of the objectives allows the researcher to limit their study to its essentials.

Research problem, objective, and hypothesis: Example

Research problem: Canada, like many other states, has been adopting measures to combat the coronavirus pandemic both at the federal and provincial levels. These measures restrict the rights and freedoms of Canadian citizens, such as the obligation to stay isolated for 14 days after returning to Canada, social gathering prohibitions, and business and school closures, among others. Although for both the official and opposition political leaders, argue that these measures are necessary and legitimate, voices have been raised against their constitutionality.

Research question: Are the measures adopted by Canada to combat the Covid-19 pandemic constitutional?

Objective: To examine the constitutionality of the federal and provincial measures adopted by the Canadian governments to combat the coronavirus pandemic.

Hypothesis: The federal and provincial measures adopted by the Canadian governments to combat the coronavirus pandemic are unconstitutional because they do not meet the Oakes test.

Theoretical framework

The theory or the line of research with which the researcher works.

The selected theory has to inform the formulation of the problem, the justification for the study, the questions and hypotheses, the selection of instruments, and the choice of methods.

Ultimately, the findings have to be analyzed in terms of how they relate to the theory or line of research underpinning the study.

The theoretical framework is the structure that supports the theory of the research project; and it establishes the perspective by which the problem is examined.

How to elaborate the theoretical framework

The theoretical framework is determined by the characteristics and needs of the research.

To develop the theoretical framework, the literature should be reviewed (consultation of bibliography and other sources).

A theory must be adopted or a theoretical perspective developed to explain what, how, when, and why the research object occurs.

The theoretical framework is a detailed description of each of the elements of the theory that will be directly used in the development of the research.

Example of a theoretical framework

Research object: The rights of Canadian citizens stranded in foreign countries due to Covid-19 travel restrictions.

The problem will be analyzed in light of Critical Legal Studies perspective, which assumes that the Law constitutes an instrument used as a symbol for the legitimation of power or domination.

This theoretical approach will allow us to analyze the ideological nature of the regulations on travel restrictions during the Covid-19 pandemic.

Literature review

The purpose of the literature review is to place research in the context of what is already known about a topic.

The literature review is conceived of a systematic and critical exposition of the theoretical and empirical knowledge produced on a certain subject.

It helps formulate the problem, produce the hypothesis; and it also helps contextualize the discussion of the findings.

At the undergraduate level, the literature review need not be exhaustive, but it needs to be relevant.

The literature review may not be general. It must be closely related to the research objective.

The literature review is not a mere list of quotes from authors, but rather it is the analysis of previous research on the research problem.

The literature review implies evaluating and synthesizing different sources to obtain a broad overview of the field within which the research will be situated.

It is necessary to identify and group common and emerging approaches, patterns, trends, areas of conflict, controversies, and gaps within the relevant literature.

When doing the literature review, it is necessary to compare, contrast, synthesize, and argue what is proposed by each author.

The works discussed in the literature review, generally speaking, should be used in the development of the research project.

Example of a poor literature review

Sabatelli, Buck and Dyer (1982) understand that having good non-verbal communication skills can be considered beneficial in criminal trials.

Weisfeld and Stack (2002) point out that non-verbal communication can consist of looking, smiling, frowning, touching, or expressions of surprise and that a defendant charged with a property offence looks at the judges more than a defendant accused of a violent crime.

Sullivan and Connor (2015) argue that having good non-verbal communication skills can be considered beneficial in criminal trials.

Example of a good literature review

For many, non-verbal communication can take a back seat to verbal communication. It is often overlooked and can be considered unimportant. However, this aspect of communication speaks volumes. Nonverbal communication can consist of looking, smiling, frowning, touching, or making surprised gestures as observed in the research study by Weisfeld and Stack (2002). It has been found that during criminal trials, those accused of property crimes display these forms of communication more frequently than those accused of violent crimes (Weisfeld and Stack, 2002). Sullivan and Connor (2015) studied non-verbal behaviors in criminal trials and found that defendants accused of property crimes look at judges in the eye for a significantly longer period of time than those charged with violent crimes. In their study focused on non-verbal communication and its relationship to criminal trials, they found that those accused of violent crimes tend to receive sentences closer to the maximum limit than those accused of property crimes. Their hypothesis is that having good non-verbal communication skills can be considered an advantage in criminal trials.

Methodology

The methodology is a procedure that allows the production of systematic and rigorous solutions to the research problem.

The methodology section has to make explicit how data are collected and analyzed.

In quantitative projects, the researcher has to measure data.

In qualitative projects, the researcher has to construct data; and in hermeneutics projects they have to gather the texts they will use for their interpretation.

The researcher has to choose the data collection tools most appropriate for their project and construct their own instruments. In qualitative projects, these can include interviews, focus groups, observations, and document analysis.

For the data analysis, researchers have to explain in detail how they worked with the data that they collected in order to obtain the information they used to provide a solution to the research problem and to answer the research question.

For qualitative projects, data analysis varies according to the adopted data collection tool. It can include: identifying common themes, establishing relationships between elements, placing elements together in a certain form, separating material elements into constituent elements, studying the elements or essential features of a concept, and discerning elements into meaning units, among many other processes.

For purely hermeneutics projects, data analysis is replaced with interpretation of texts following the hermeneutics circle. This implies a dialectical process in which the researcher navigates between the parts and the whole of the text to achieve an adequate understanding of the text. This approach also involves a translation process, as a new text is produced, which, while respecting the essence of the original text, provides an added value to the text under interpretation by emphasizing on its historical context.

Research conclusions

Conclusions

The conclusions summarize the discussions of the whole research work.

They have to restate the problem, the hypothesis, and the major findings. They also needed to remind the reader of the relevance of the project.

They may also include directions for future research and/or make recommendations based on the implications of the research project.

Quantitative research

- Quantitative research is associated with the scientific model, which is based on the premise that there is an objective world from which the scientist can extract data and verify it through empirical research, that is, a process of observations about the world that involves making conjectures (hypotheses), derive predictions from them as logical consequences, and then perform empirical observations or experiments based on those predictions.
- **Quantitative research methods**
- The experiments carried out in quantitative research projects produce quantitative data, since they aim to measure the research object.
- Quantitative research collects these data in numerical form, which can be classified into different categories, or in order of hierarchy, or in units of measurement.
- **Quantitative research: data analysis**
- Statistics make it possible to convert quantitative data into useful information for decision making.
- Statistics allow data to be summarized, describing patterns, relationships, and connections.
- Statistics can be descriptive or inferential.
- Descriptive statistics allow the data obtained to be summarized, while inferential statistics are used to identify statistically significant differences between data groups (such as the intervention and control groups in a randomized control study).

Characteristics of quantitative research

- Quantitative research aims to control variables by conducting controlled studies in laboratories.
- The research aims at objectivity, i.e., to produce results without bias.
- The research design is determined before research begins.
- For the quantitative researcher, reality is objective and exists separate from the researcher. Reality can be examined and verified by anyone.
- The research object is external to the researcher.
- Research is used to test a theory and ultimately to support or reject it.

Qualitative research

- The objective of qualitative research is to understand the social reality of individuals, groups and cultures as closely as possible to what its participants feel or experience it.
- Qualitative research implies an interpretive and naturalistic approach to the world. This means that qualitative researchers study objects in their natural settings, trying to make sense of, or interpret, phenomena in terms of the meanings that people attribute to them.

Qualitative research methods

Qualitative research has not adopted a single method of data collection and analysis, but rather it takes methods, techniques, and instruments from various disciplines and research practices.

- Interviews.
- Surveys.
- Focus groups.
- Observation and ethnographies.
- Action research.
- Life histories.
- Introspection.
- Case studies.
- Artifacts, texts, and cultural productions.

Qualitative methods: Interviews

Interviews collect in-depth content in a one-on-one setting.

- Structured.
 - Verbally administered questionnaires, in which a list of predetermined questions are asked, with little or no variation and with no scope for follow-up questions.
- Semi-structured.
 - Several key questions that help to define the areas to be explored, but also allows the interviewer or interviewee to diverge in order to pursue an idea or response in more detail.
- Unstructured.
 - Open questions and follow ups.

Qualitative methods: Surveys

It is the process of conducting research using surveys that researchers send to survey respondents. The data collected from surveys is then analyzed to draw meaningful research conclusions.

They involve the use of standardized questionnaires or interviews to collect data about people and their preferences, thoughts, and behaviors in a systematic manner.

The survey method can be used for descriptive, exploratory, or explanatory research.

Qualitative methods: Focus groups

The researcher engages a small group of participants in a conversation designed to generate data relevant to the research question.

The main aim of the focus group is to find answers to the “why” “what” and “how” questions.

They can contain anywhere from 5 to 15 participants.

Qualitative methods: Observation and ethnographies, and action research

Observation. A researcher studies people as they go about their daily lives without participating or interfering.

Ethnographic research. It is the most in-depth observational method that studies people in their own environment. This method requires the researchers to adapt to the target audiences’ environments. This research design aims to understand the cultures, challenges, motivations, and settings that occur. Instead of relying on interviews and discussions, the researcher experiences the natural settings first hand.

Action research. It is a reflective process of progressive problem solving led by individuals working with others in teams or as part of a "community of practice" to improve the way their practice and how to address issues and solve problems.

Qualitative methods: Life history

It is a dynamic process between researcher and participant that endeavors to provide a full-scale autobiographical account” by allowing interviewees to relate their entire life, from childhood to the present.

The researcher and the participant construct a narrative in a collaborative fashion, utilizing multiple data sources such as one-on-one interviews and observations. A variety of artifacts, whether they are in hard copy (e.g., a diary) or digitized (e.g., an e-mail message), may also play a role in data collection and analysis.

In its finished state, a life history document is a contextually bound representation of the life of the participant.

Frequently, the questions and findings highlighted by a life history have illuminated broader cultural and societal concerns that might have otherwise escaped scholarly attention.

Qualitative methods: Introspection

It is an ongoing process of tracking, experiencing, and reflecting on one’s own thoughts, mental images, feelings, sensations, and behaviours.

It involves investigating one’s own subjective experiences, examining one’s lived experiences for insights or knowledge generation.

Qualitative methods: Case study

A case study is a detailed study of a specific subject, such as a person, group, place, event, organization, or phenomenon.

It enables researchers to conduct an in-depth exploration of intricate phenomena within some specific context.

Qualitative methods: Artifacts, texts, and cultural productions.

It is an unobtrusive methods for collecting information about human behaviors.

It involves an intense microanalysis of documents and artifacts to answer an almost unlimited number of research questions.

Examples of artifacts include books, media materials; letters, e-mail records, furniture, objects, etc.

Triangulation

- Triangulation as a qualitative research strategy is used to test validity through multiple methods or data sources in order to develop a comprehensive understanding of phenomena.

Qualitative research data analysis

- Qualitative research is infinitely creative and interpretive.
 - Qualitative interpretations are constructed and various techniques can be used to make sense of the data, such as content analysis, grounded theory, thematic analysis, or discourse analysis.
 - The qualitative perspective seeks to understand the meanings, characteristics, and symbols of the research object, trying to see the whys and hows. I
 - Instead of quantifying, the qualitative perspective wants to understand the research object and explore it without always resorting to previous categories of analysis.
 - Unlike quantitative research, qualitative research attempts to discover the object while research is being conducted.
-
- The research object is not something external to the researcher, but rather the object is a construction that arises from the interaction between the researcher and what the researcher determines and defines as an object.
 - The more the researcher is aware of their own subjectivity and how it influences the research object, the further the research moves away from the quantitative perspective of the scientific model.
 - At the far end of the quantitative perspective, the researcher not only makes their subjectivity explicit, i.e., their social class, gender, sexual orientation, race, and even their emotions, but they investigate it in a kind of self-analysis. In other words, subjectivity itself becomes part of the investigation itself that materializes in self-reflective research.
 - In this way, the boundaries between the object, the subject, and the purpose of the research are blurred.
 - The research objective is not only the discovery of the research object but also the self-discovery of the researcher himself.

Characteristics of qualitative research

- Phenomena and events can be properly understood only when viewed in context. Therefore, a qualitative researcher immerses himself/herself in the field, in a natural environment.

Inquiry contexts are not contrived; they are natural. Nothing is predefined or taken for granted.

- Qualitative researchers want their research subjects to speak for themselves, to provide their perspectives in words and actions. Therefore, qualitative research is an interactive process in which the research subjects teach the researcher about their lives.
- The qualitative researcher is an integral part of the data, without the active participation of the researcher, there is no data.
- The research design evolves during the research and can be adjusted or changed as research progresses.
- For the qualitative researcher, there is no single reality. Reality is subjective and exists only in reference to the observer.
- Theory is based on data and emerges and evolves during the research process.

Abductive reasoning

- Peirce's original idea focused on the fact that the human mind makes inferences based on intuitions and associations, combining the observation of a new phenomenon with already internalised background knowledge.
- The inference that explains the new phenomenon then comes to the perceiver "like a flash".

Abductive reasoning

In abductive approach, the research process starts with 'surprising facts' or 'puzzles' and the research process is devoted their explanation.

Abductive reasoning starts from the description of an event or phenomenon and generates a hypothesis, which explains, abductively inferring, the event or phenomenon and the existence of underlying causal mechanisms.

In Peirce's terms, "abduction is the process for the formation of explanatory hypotheses and constitutes the only logical operation that allows the introduction of a new idea."

Abducting reasoning can be used to create a new theory.

Examples of abductive reasoning

Einstein's work was not just inductive and deductive, but involved a creative leap of imagination and visualization that scarcely seemed warranted by the mere observation of moving trains and falling elevators. In fact, so much of Einstein's work was done as a "thought experiment".

A medical diagnosis is an application of abductive reasoning: given this set of symptoms, what is the diagnosis that would best explain most of them?

When jurors hear evidence in a criminal case, they must consider whether the prosecution or the defense has the best explanation to cover all the points of evidence.

Law and Science

Law is not a science

- A branch of practical reason.
- An art (argumentation/social governance by rules of conduct).
- A normative phenomenon.
- A social ordering instrument.
- A body of applied learning.
- A product of custom, legislation, and judicial development.
- Law has remained Aristotelian, while science has built up a new world of analyzed, systematized, and recorded facts.
- It is not being susceptible of being falsified because its nature is prescriptive.
- Pre-paradigmatic.
- Law does not follow the scientific method.
- Law does not discover new elements or principles, or put new instruments or knowledge at the service of humanity.

Law as a science

- A well-defined community of legal scholars (faculty members, researchers, authors) who see law as scientific.
- Law and legal scholars played a pivotal role in the creation and expansion of modern science.
 - Francis Bacon law, like astronomy or chemistry, was a science, and thus was susceptible to the application of reason and the new scientific method.
- By the end of the seventeenth century both science and law (especially under the influence of Roman law) were moving to new more systematic, syllogistic paradigms, based upon the belief that by reason and principled argument, legal truth could best be discovered.
- Thousands of associations devoted to the research of law around the world.
- Conferences and congresses.
- Peer-reviewed publications.
- Higher education teaching.
- Recognition of other scientific disciplines
- Demarcation of boundaries with other disciplines in the production of scientific knowledge.

Methods and their contexts

- Context of discovery.
- Context of justification.
- Context of application.

Context of discovery

It refers to the way in which a new theory is generated, i.e., the way in which scientists propose new ideas, concepts, hypotheses and principles.

It has to do with the way in which the ideas that lead to the development of a theory occur to its creator. The generation of a new theory does not have a logic or a particular method, nor does it follow any standard pattern. What allows the creation of a science in a certain case does not work in others.

Every discovery has an irrational element or a creative intuition and calls for breaking a large number of routine schemes of the epistemological and methodological tradition and, especially, the representation of research development as a succession of different, predetermined stages.

Context of justification

It implies the validation of the theory, i.e., the determination of the epistemological validity of the knowledge produced.

This context answers questions such as: “Can a claim be justified? And if so, how? Is it verifiable? Does it logically depend on some other claims? Or does it contradict them?”

Beyond these general questions and given that there are no external criteria and validation objectives applicable to all sciences, discipline adopts its own method of justification.

Context of application

The application of the theory.

In law, this context is highly connected to legal practice, in particular, with the settlement of disputes in court.

The legal methods: context of discovery

No single method.

Every discovery has an irrational element or a creative intuition.

Ideas taken from social practice, governmental policies, cultural artifacts, other theories, other disciplines, legal texts, and personal experiences.

The legal methods: context of justification

Doctrinal legal method

A systematic process of interpretation, analysis, and critical evaluation of the legal norm, i.e., laws, principles, concepts, and doctrines.

The researcher discerns, hierarchizes, classifies, and critically reviews the legal norm, places it within a certain legal category, and evaluates its place within the legal order.

The crucial question that the legal researcher asks with respect to a legal norm is whether it is valid in light of its logical relation to other norms (legal order).

Doctrinal legal method: Characteristics

- It is used only in Law.
- It is developed in accordance with standards and rules accepted in the legal discipline.
- It uses specific language and specific cognitive skills.
- It includes a high level of criticism.

- It includes the literature review as background and context of the research problem.
- Its research object is the norm (a rule, the law).
- It deals with texts (the norm, auxiliary norms, cases, treaties, journal articles, books, etc.).
- The legal scholar has to interpret all the elements of the text, including grammatical, semantic and extensive ones.
- The task of the researcher is to try to decipher the current meaning of the norm as authentically as possible.
- Technically, the hypothesis is actually a pseudo-hypothesis, i.e., a statement that is not empirically verifiable.
- Necessary elements of a research project: literature review (bibliographic review), historical analysis, content analysis (by reading legislation, jurisprudence, doctrine and other documents).
- It involves a rigorous systematic exposition, analysis and critical evaluation of legal rules, principles or doctrines and their inter-relationship. It arranges the existing law in order and provides thematic parameters for such an order. It also concerns with critical review of legislations and of decisional processes and their underlying policy.
- It also provides the systematic exposition of the rules which are governing in a particular legal category.
- It involves a critical conceptual analysis of all relevant legislation and case law to reveal a statement of the law relevant to the matter under investigation.

The legal methods: context of application

Legal method

Agreement on the how and the what for of the method.

What for: to predict (common law) or to influence (civil law) the outcome of a court decision.

How: data or facts (the object of study in law can be observed in an inductive way and through deductive reasoning a valid conclusion can be reached, i.e., a uniquely correct result for the case in question).

Disagreement on what the data or facts are.

The legal methods: context of application

Facts

- Legal facts to be found –through empirical observation- in appellate cases (Langdell).
- A body of reports, of treatises, and of statutes (Holmes).
- Principles of natural law (Natural Law scholars).
- The ideology that animates the judges and motivates their actions (Ross).
- The rules of conduct derived from –Roman- history and society (Savigny).
- The *homo juridicus* and his/her practices and what drives his/her conduct (European Legal Realists).
- The body of laws in effect in a given jurisdiction (Kelsen).

Christopher Columbus Langdell

- The case method, i.e., the dissection of edited appellate cases compiled in a casebook and the analogy of the law library to the laboratory.
- The scientific approach pioneered by Langdell in the 1870's had two components: empiricism and rationalism.
- Langdell argued that legal scholars were also empirical investigators. They sought for legal principles rather than physical rules. The sources of their raw data were legal facts to be found in appellate cases. The rational aspect was the belief that legal reasoning must be deductive.
- The first principles to which deductive method must be applied could be attained not by reason or logic alone but through empirical research in the decided cases.

Legal and Social Sciences

- Movement in North America. 1980's.
- The 20th century has witnessed movements toward law and social science, law and psychology, among others.
- In each of these movements the major contribution of the ancillary subject has been the imposition of its perspective and method upon law.

The legal methods and other disciplines

Legal researchers have always struggled to explain the nature of their activities to colleagues in other disciplines.

- Those from other disciplines consider the method vague, intuitive and archaic. For them, the lawyer does not do research. Legal research is not really academic.
- For lawyers and legal scholars, researchers who use the qualitative methods of social sciences do not do legal research and do not understand the law.
- When dealing exclusively with legal norms, the doctrinal legal method is appropriate.
- When researching institutions, agents, policies, social consequences or implications of legal norm, it may be more appropriate resort to social sciences methodology.
- In all cases, it is necessary to reflect on this method and make it explicit so that the method can be understood by those outside the discipline.

Doctrinal legal method: Characteristics

The aim is to answer the question 'what is the law?' in a particular situation. In the case of practising lawyers or judges this will be a real situation requiring an immediate answer to the question. For the legal scholar, the situation will be hypothetical and the purpose is to undertake a more in-depth analysis which is capable of informing the deliberations of practitioners and judges in future cases.

In either case, the initial process of applying a rule of law to a factual situation can be understood as an exercise in deductive logic.

Major premise: identifies a general rule of law which requires a specified legal outcome when particular facts are present in a situation.

Minor premise – describes a particular factual situation.

Conclusion – states whether the rule in the major premise therefore applies to the facts in the minor premise, and whether the specified legal outcome therefore takes effect.

Types of legal research

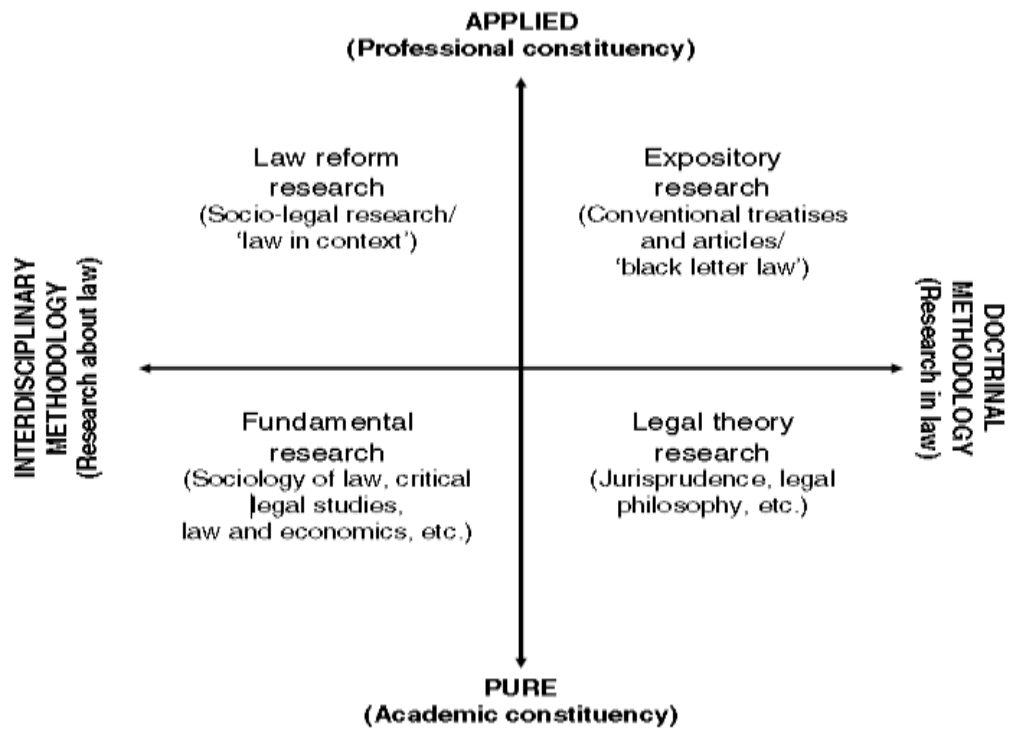


Figure 3.1 Legal research styles (Arthurs, 1983).