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Scientific Knowledge and Scientific Method in Scientific Research

Alo Liliweri

Professor, Cross-Cultural Communication Science,
The Department Of Communication,
University Of Nusa Cendana - Kupang / Indonesia.

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ABSTRACT

"Research" is the most important activity in the framework of science development. A new definition of science based on the distinction between the; (1) activity of scientists means "science" and (2) the product of that activity means "Science". Out of this scientific, there is a science of knowledge we will call "Science", which has special properties that are quite different from those of "science" (the human activity) or of any other human activity. Therefore, the discussion of research methodology cannot be separated from several concepts, among others, science, knowledge, scientific knowledge, scientific methods. This paper will also feature three models of scientific research (classical models, pragmatic models, and empirical logic models). We will also discuss about, what is research, scientific research (types of scientific research (explorative, descriptive, and explanatory), and recent research approaches (deductive research approach, inductive research approach, and abductive). All of this paper is packaged in the title "scientific knowledge and scientific method in scientific research".

What is Knowledge?

Does knowledge differ from opinion or belief? Are there different types of knowledge? How do we decide what constitutes knowledge? As a starting point in an attempt to understand the concept of knowledge, a variety of definitions and schools of thought will be examined. Based on *The Concise Oxford Dictionary* defines knowledge as; (1) a. awareness or familiarity gained by experience (of a person, fact, or thing); b. a person's range of information; (2) a. theoretical or practical understanding of a subject, language, etc. b. the sum of what is known; (3) true, justified belief; certain understanding, as opposed to opinion." This definition can be more properly described as a collection of definitions. Do they make sense? Are they compatible? How do they contribute to our understanding of knowledge?

** Professor of Cross Culture Communication, University of Nusa Cendana, Kupang/West Timor, Indonesia.*

What is Science?

According to Matthew Bobrowsky (2007), "Science" is; (1) the study of the workings of the material universe. Scientists try to discover facts about the universe and to find out how those facts are related. Those relationships are expressed as theories or laws of nature; (2) a process for acquiring knowledge. This does not mean that there is a definite series of steps that scientists follow, the way a cook would follow a recipe; (3) a collection of facts. Scientific knowledge encompasses an enormous amount of information about the physical universe; (4) organizing principles and laws. Besides discovering the objects in the universe — from atoms to galaxies — scientists have also found that these objects interact only in specific ways that can be described by laws; (5) science is a culture, members of the scientific community have developed a culture that engenders trust and sharing of information; (6) an object of study by sociologists and philosophers. In recent decades, there have been a number of new academic disciplines devoted to the study of science and scientists; (7) a profession, but not just any profession. People don't enter a scientific career to become rich; and (8) science is a symbol of credibility. People frequently tack "science" onto the name of an area of interest when they wish to add an air of authority.

Pierre C Hohenberg (2010) proposes a new definition of science based on the distinction between the (1) *activity of scientists* means "science" (sometimes we said research activity), and (2) *the product of that activity* means "Science" (sometimes we said the body of knowledge). Out of this scientific activity there emerges a body of knowledge we will call "Science", which has special properties that are quite different from those of "science" (the human activity) or of any other human activity. This body of knowledge, of which the clearest example is arithmetic, is a unique creation of the human community. It must be stressed, however, that the features of Science that lend it authority are also the source of limitations of Science, limitations that need to be identified and understood.

These definitions of science are intended to clarify the nature of scientific knowledge, its authority as well as its limitations, and how scientific knowledge differs from other forms of human knowledge. Now, what is science? According to *Wisconsin Department of Public Instruction* (1986), a working definition of science is a human activity through which problems and questions dealing with natural phenomena can be identified and defined, and solutions proposed and tested. In this process, data are collected and analyzed, and available knowledge is applied to explaining the results. Through this activity, investigators add to the store of knowledge, thereby helping people better understand their surroundings. Applications of this knowledge also may bring about changes in society and the cultural order and may have a direct bearing on the quality of life.

The body of knowledge we call Science is exemplified by elementary arithmetic: it has the following properties: (1) Science is collective, public knowledge; (2) Science is universal and free of contradiction; (3) Science emerges from science; and (4) Science is nevertheless bathed in ignorance and subject to change. These properties imply that many questions that are of great interest to humanity are out of reach to Science since they necessarily involve individual and group commitments and beliefs. Examples are questions of ethics, religion, politics, art and even technology, for which diversity is a fundamental virtue.

We can summaries the consept of science, according to *The National Academy of Sciences* (2008), science is "the use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process"; and Stephen Jay Gould (1997), science is the net of science covers the empirical universe: what is it made of (fact) and why does it work this way (theory) (Pierre C Hohenberg, 2010).

What Is Scientific Knowledge?

How the relationship between science and knowledge? Anol Bhattacherjee (2012) said that *the purpose of science is to create scientific knowledge*. Scientific knowledge refers to a generalized body of laws and theories to explain a phenomenon or behavior of interest that are acquired using the scientific method. Laws are observed patterns of phenomena or behaviors, while theories are systematic explanations of the underlying phenomenon or behavior. For instance, in physics, the Newtonian Laws of Motion describe what happens when an object is in a state of rest or motion (Newton's First Law), what force is needed to move a stationary object or stop a moving object (Newton's Second Law), and what happens when two objects collide (Newton's Third Law). Collectively, the three laws constitute the basis of classical mechanics – a theory of moving objects.

Sandoval (2005) reviewed Osborne and others' definitions of science epistemology (e.g., Driver *et al.*, 1996; Lederman *et al*., 2002; McComas and Olson, 1998) and presented a more manageable list of four broad epistemological themes, which we pause to discuss briefly. ***First***, Sandoval asserts that viewing scientific knowledge as constructed is of primary importance that underscores a dialectical relationship between theory and evidence. Students, if they are to understand what science is, must accept that it is something that people do and create. From this flows the implication that science involves creativity and that science is not science because it is "true" but because it is persuasive. ***Second*** theme is that scientific methods are diverse: there is no single "method" which generically applies to all scientific inquiries (experiments may be conducted in some fields, but not in others). Rather than relying on one or several rote methods, science depends on ways of evaluating scientific claims (e.g., with respect to systematicity, care, and fit with existing knowledge). ***Third***, scientific knowledge comes in different forms, which vary in their explanatory and predictive power (e.g., theories, laws, hypotheses). This is a theme often overlooked in traditional analyses (including Osborne's) but one that is central to understanding the constructive nature of science and the interaction of different knowledge forms in inquiry. ***Fourth,*** Sandoval asserts that scientific knowledge varies in certainty. Acknowledging variable certainty, Sandoval argues, invites students to engage the ideas critically and to evaluate them using epistemological criteria. Another approach to defining the aspects of understanding the epistemology of science that science curriculum should inhere is to consider the aspects of epistemology that have been linked to enhancing the development of science understanding. Although the literature does not offer a systematic treatment of this notion, there are pockets of evidence that suggest a relationship between aspects of epistemology and students' understanding and use of scientific knowledge.

What Scientific Method?

The scientific method is also a continuous process that begins with observations about nature. It is assumed that everyone is naturally curious, so they often ask questions about things they see or hear, and from here they often develop ideas or hypotheses about why things are as they are. The best hypothesis leads to predictions that can be tested in various ways. The strongest hypothesis test comes from carefully controlled experiments when collecting empirical data. All this depends on how well the additional tests fit the prediction, the original hypothesis may require refinement, change, expansion or even rejection. If a particular hypothesis becomes strongly supported then general theory can be developed (Garland, 2015).

Although procedures vary from one field of inquiry to another, they are often different from one another. The process of the scientific method involves making predictions (hypotheses), which decreases predictions as logical consequences and then conducts experiments or empirical observations based on those predictions. Hypotheses are conjectures, based on the knowledge gained while seeking answers to these questions. The hypothesis may be very specific, or perhaps broad. The scientists then test the hypothesis by doing experiments or research. The scientific hypothesis must be "disguised", implying that there is an identification of possible experimental or observational results that are contrary to the predicted predictions of the hypothesis; if not then the hypothesis cannot be tested meaningfully (Popper, 1959).

Elements of Scientific Method

There are various ways to describe the basic methods used in scientific research. The scientific community and the philosopher of science scientifically agree on the classification of the following component methods. That the methodological and organizational elements of this procedure tend to be more typical of the natural sciences than the social sciences. However, the cycle of formulating hypotheses, testing and analyzing the results, and formulating new hypotheses, will resemble the cycles described below. The scientific method is a recurring cycle process through which information is constantly revised;

1. *Characterization* (observation, definition, and measurement of the subject of inquiry)

2. *Hypothesis* (theoretical and hypothetical explanation of subject observation and measurement)

3. *Predictions* (inductive and deductive reasoning from hypotheses or theories)

4. *Experiment* (test of all the above) (Godfrey-Smith, 2009; Brody, 1993; Kuhn, 2012; Galison, 1987).

Every element of the scientific method is subject to peer review for possible errors. This activity does not explain all that scientists do (see below) but mostly applies to experimental science (eg physics, chemistry, and biology). The scientific method is not a single recipe: it takes intelligence, imagination, and creativity. In a sense, this is not a set of standards and procedures that are not felt to be followed, but this is an ongoing cycle, continuing to develop more useful, accurate and comprehensive models and methods. For example, when Einstein developed a special and general theory of relativity, he in no way rejected or abandoned Principia Newton. On the contrary, if astronomically large, vanishingly small, and very quickly removed from Einstein's theory - all phenomena that Newton cannot observe - the Newtonian equation is what remains. Einstein's theory is the extension and refinement of Newton's theory and, thus, enhances his belief in Newton's work. The disaggregated and pragmatic scheme of the above four points is sometimes offered as a guide to continue:

1. Define a question

2. Gathering information and resources (observe)

3. Make an explanatory hypothesis

4. Test the hypothesis by conducting an experiment and collecting data in a reproducible manner

5. Analyzing data

6. Interpret data and draw conclusions that serve as a starting point for a new hypothesis

7. Publish results

8. Retest (often done by other scientists) (Crawford 1990).

The iterative cycle attached to this step-by-step method lasts from point 3 to 6 back to 3 again. While this scheme describes the typical hypothesis/testing method, it should also be noted that a number of philosophers, historians, and sociologists of science, including Paul Feyerabend, claim that the description of such a scientific method has little to do with the ways in which science is actually practiced (Bynum & Porter, 2005).

So what exactly is the "scientific method"? The scientific method refers to a set of standard techniques for building scientific knowledge, such as how to make valid observations, how to interpret the results, and how to generalize the results. The scientific method allows researchers to independently and impartially test pre-existing theories and previous findings, and direct them to open debate, modification, or refinement. The scientific method must meet four characteristics:

1. *Replicability* (replicability): others must be able to replicate or repeat scientific studies independently and obtain similar results, or obtain unidentified results.

2. *Precision* (precision), a theoretical concept, which is often difficult to measure, must be defined precisely such that others can use the definition to measure concepts and test the theory.

3. *Falsifiability* (falsifiability): a theory must be expressed in such a way that it can be denied. A theory that can not be tested or falsified is not a scientific theory and such knowledge is not scientific knowledge. An improperly defined theory or whose concept cannot be accurately measured and tested, and therefore unscientific. Sigmund Freud's idea of psychoanalysis falls into this category and is therefore not considered a "theory", although psychoanalysis may have practical utility in treating certain types of diseases.

4. When there are many explanations of a phenomenon, scientists must always accept the most simple or *economically logical explanation.* This concept is called parsimony or "Occam razor" ("Occam's razor"). Parsimoni prevents scientists from pursuing a theory that is too complex and strange with a number of concepts and endless relationships that might explain a bit more but nothing special.

Scientific Methods and Research Objectives

It is clear here how important the role of the scientific method, which can be distinguished by non-scientific methods, as fundamental for researchers to define research objectives. That is, the research method is to verify the correctness of the results, as a result, the researcher must formulate the research objectives appropriately. We always say, 'end to the road', which means that research says only if used for:

1. *Categorization.* This involves the formation of object typology, event or concept, ie a set of names or 'squares' in which all of these can be sorted. Categorization can be useful in explaining what 'things' include and how they are.

2. *Describing.* Descriptive research relies on observation as a means of data collection. It tries to check the situation to establish what the norm is, that is, what can be predicted to happen again under the same circumstances.

3. *Explain.* This is a descriptive type of study designed specifically to deal with complex problems. It aims to move beyond 'just getting the facts' to understand the various other elements involved, such as human, political, social, cultural and contextual.

4. *Evaluation.* It involves judgment about the quality of the object or event. Quality can be measured in terms of absolute or by comparison. To be useful, the evaluation method should be relevant to the context and purpose of the study.

5. *Compare***.** Two or more contrasting cases can be examined to highlight differences and similarities between them, leading to a better understanding of phenomena.

6. *Correlate.* The relationship between the two phenomena is investigated to see if and how they affect each other. The relationship may be just a loose relationship at one extreme or a direct link when one phenomenon causes another - measured as the association level.

7. *Prediction.* This can sometimes be done in a research area where the correlation is known. Predictions of possible future behavior or events are made on the basis that if there is a strong relationship between two or more past characteristics or events, then this must exist in a similar state in the future, leading to predictable results.

8. *Control.* Once you understand an event or situation, you may be able to find a way to control it. For this you need to know what the cause and effect of the relationship is and that you are able to exert control over vital ingredients. All technology depends on the ability to control this. You can combine two or more of these goals in a research project, with sometimes one goal to achieve before the next, for example, you usually have to be able to

explain how something happened before you can figure out how to control it. (Muaz, 2013); **1]**

Three Model of Scientific Research

In the philosophy of science, the model of scientific research (inquiry) has two functions; (1) to provide a descriptive explanation of how scientific inquiry is conducted in practice, and (2) to provide an explanation of why scientific inquiry succeeds in obtaining genuine knowledge. At a certain point in the past, at least in the time of Aristotle, philosophers recognize that fundamental differences must be drawn between two types of scientific knowledge ... ie knowledge of.... (knowledge that) and what causes something is called knowledge (knowledge why). The first type of knowledge (knowledge that) is descriptive, while knowledge of the second type (knowledge why) is an explanation, ie, explanative knowledge that provides a scientific understanding of the world (Salmon, 1990). It is these two types that require scientific inquiry to refer to the various ways in which scientists study the natural world and offer explanations based on evidence derived from their work. There are at least three models of scientific inquiry: (1) classical models, (2) pragmatic models, and (3) empirical logic models.

Classic Model

The classical model of scientific inquiry comes from the work of Aristotle "Prior Analytics". This work investigates logic scientifically, so Aristotle is regarded as the Father of Logic, and since then all aspects of Aristotelian philosophy have continued to be the object of academic study (Jonathan, 1995). Aristotle has been described by great artists alongside Raphael and Rembrandt. It is even mentioned that early modern theories, such as the blood circulation theory of William Harvey, and Galileo Galilei's kinematics developed in reaction to Aristotle. In the 19th century, George Boole discussed Aristotelian logic as a mathematical basis with logical systems in algebra, as well as in the early 20th century, Martin Heidegger gave a new interpretation of Aristotle's political philosophy. On the other hand, Aristotle is widely criticized, even ridiculed by thinkers such as the philosopher Bertrand Russell and the biologist Peter Medawar, as well as Ayn Rand and Alasdair MacIntyre, Armand Marie Leroi have reconstructed the biology of Aristotle.

Pragmatic Model

In 1877 Charles Sanders Peirce characterized the investigation in general, that investigation was not pursued purely for pursuit of truth but also as a tenacious endeavor, or even called a struggle to avoid any obstacles to research because of the factors of surprise, disagreement etc. to achieving a secure belief, a belief in which one is ready to act. Pierce has framed a scientific inquiry as part of a wider spectrum that continues to be spurred, such as investigation in general, especially with regard to the principle of skepticism, not just skeptic verbal or hyperbolic, which is considered fruitless (Kenneth, 2009). Pierce describes four methods of determining correctness of opinion or correct conclusions in the investigation, namely;

1. *The method of tenacity* - which says that 'sticking to the initial beliefs' not only brings comfort and firmness to a researcher but leads to an attempt to ignore conflicting information or the views of others as if to say that essentially truth is private rather than public. This principle is clearly contrary to social impulses because one may be concerned with the opinions of others when the opinion is as good as the original person's opinion (Jefferson calls Bacon, Newton, and Locke, as if the trinity of the greatest philosophers in the world).

2. *The method of authority* - that only the authoritative party is authorized to resolve or resolve disagreements, although sometimes the deal is resulted by brutal acts. This type of decision method for the truth of the outcome of such an inquiry has resulted in long-term results but cannot operate thoroughly, including not being able to suppress skepticism, especially when researchers can learn from other communities either in the past or in the past.

3. *The a priori method* - is a method of encouraging conformity, in a less brutal way but it can cultivate opinions to satisfy the taste of truth. This method, we can see in various conversations if there is to say "what is reasonable." Thus this method depends on the mode in the paradigm that continues to spin over time. This method does appear to be more intellectual and distinguished than the two methods of the former method, because the investigator can defend his unintentional and fluid beliefs, then subjugate some thoughts to doubt the outcome of the investigation.

4. *Scientific method* - is the method by which the investigator considers his inquiry imperfect and deliberately examines himself and the results of his investigation, then criticizes, corrects, and corrects himself.

Peirce argues that rather than the researchers experiencing slowness in ratiocination, let alone relying on traditional instincts and sentiments to justify practical matters, the scientific etiquette is considered most suitable for theoretical research, which in turn should not be fouled by other methods and practical purposes. Pierce said the "first rule" for researchers is 'learning, always wanting to learn, the consequence is that he does not have to get in the way of his investigation'. Scientific methods outperform other methods deliberately designed to arrive at the most secure beliefs, which form the cornerstone of most successful practices. Starting from the idea that people seek not only the truth but to overcome feelings of doubt or obstacles of doubt. Peirce shows how, through struggle, truth can be obtained for the integrity of belief in seeking and obtaining the truth, including as the guidance of the most potential practice (Anellis 1993).

For Peirce, truth is a sign of correspondence (in particular, proposition) for an object, pragmatically, not as a real consensus of some particular community (as will be questioned through expert polls), but rather as a final opinion which for all researchers reach it, sooner or later remain unavoidable (Muller, and Joseph, 2000; Arens and Smith, 1994).) Together with that, Pierce also defines the true truth it must have a 'right sign' (eg the truth of the object is related to the possibility or qualities, or facts of actuality or harsh facts, or necessities or norms or laws), which is what is independent of any limited and pragmatic opinion of society, depends only on the ultimate opinion destined for adequate inquiry. The investigation leads to "Do the science." Conceptions of truth and the real are involved a community idea without clear boundaries (and thus potentially self-correcting as far as necessary) and able to improve knowledge. In conclusion, "logic is rooted in social principles" because it depends on a point of view that is, in a sense, unlimited (Awbrey & Awbrey and Parker, 1998).

Empirical Logic

Wesley Salmon (1990) initiated his historical survey of scientific explanations with what he called 'acceptable views', as in logic of explanation (1948) and culminated in the scientific aspect of Hempel (1965). Salmon concludes his analysis of this development in the following Table.

Laws /Explananda	Particular Facts	General Regularities
Universal Laws	D-N Deductive-Nomological	D-N Deductive-Nomological
Statistical Laws	I-S Inductive-Statistical	D-S Deductive-Statistical

In this classification, it appears that the Deductive-Nomological (D-N) explanation of an event is a valid deduction, whose conclusion states that the results to be explained actually occur. The deductive argument is called explanation, with the premise called explanan (L: explaining) and the conclusion called explanandum (L: what is described), but all depends on a number of additional qualifications against explanation so that we can give truth on the rank above the scale from potential to truth. Not all explanations in science are D-N types. There is also an Inductive-Statistical (I-S) explanation of an event by entering it under statistical law, not categorical or universal law, and the mode of subsumption itself is inductive rather than deductive. The D-type N can be seen as a case that limits the more general I-S type, that the size of the involved certainty is complete, or the probability of 1 to the previous cases, even if it is incomplete so the probability <1 is found in the latter case.

In this view, the way of D-N reasoning, in addition to being used to describe a particular event, can also be used to explain general order, simply by deducing it from the more general law. Finally, the type of Deductive-Statistical explanation (D-S), which is appropriately considered a subclass of the D-N type, describes statistical regularity with the deduction of more comprehensive statistics (Salmon 1990). This is the view of acceptable scientific explanations from the standpoint of logical empiricism, this view according to Salmon mastering research decisions during the quarter of the last three centuries (Salmon, 1990).

"What Is Scientific Research?"

What is Research"?

The word "research" comes from the central French "recherche" meaning "seek", the term is derived from the ancient French "recerchier", the compound of "re-" + "cerchier", or "sercher", meaning 'search '(Merriam Webster, Encyclopædia Britannica, 2011). The first world of "research" requirement was in 1577 and until now term of "research" has been defined in several different ways. In communication science we know "scientific research" (Shuttleworth, 2008). "Scientific research" is, (1) provide information for the development of science, and (2) scientific method (Anol Bhatacherjee, 2012).

What is research? Depending on who you ask, you will likely get very different answers to this seemingly innocuous question. Some people will say that they routinely research different online websites to find the best place to buy goods or services they want. Television news channels supposedly conduct research in the form of viewer polls on topics of public interest such as forthcoming elections or government-funded projects. Undergraduate students research the Internet to find the information they need to complete assigned projects or term papers. Graduate students working on research projects for a professor may see research as collecting or analyzing data related to their project. Businesses and consultants research different potential solutions to remedy organizational problems such as a supply chain bottleneck or to identify customer purchase patterns. However, none of the above can be considered "scientific research" unless: (1) it contributes to a body of science, and (2) it follows the scientific method. This chapter will examine what these terms mean **(**Anol Bhattacherjee, 2012).

According to Redman and Mory (1923), research as "a systematic attempt to acquire new knowledge." Some consider research as a movement, a movement from the known to the unknown. Research is like a cruise of discovery. We all have a vital instinct of curiosity when something unknown will confront us, we wonder and based on our curiosity that makes us investigate and reach a fuller and more complete understanding of what is unknown. This curiosity is the mother of all knowledge and methods used by humans to gain knowledge of any unknown, this can be called research. Meanwhile, John W. Creswell (2008) says, "research is the process steps used to collect and analyze information to improve our understanding of a topic or issue." Creswell's definition consists of three steps: asking a question, collecting data for answer questions, and provide answers to these questions. Finally, according to Ranjit (2011), research is "creative and systematic work done to increase the availability of knowledge, including knowledge of people, culture and society, and the use of this knowledge to design new applications." The conclusion of the above description is that research work must be based on "scientific methods", this understanding to convince us that there are also researches that are not based on the scientific method.

Scientific Research

Given that theories and observations are the two pillars of science, scientific research operates at two levels: a theoretical level and an empirical level. The theoretical level is concerned with developing abstract concepts about a natural or social phenomenon and relationships between those concepts (i.e., build "theories"), while the empirical level is concerned with testing the theoretical concepts and relationships to see how well they reflect our observations of reality, with the goal of ultimately building better theories. Over time, a theory becomes more and more refined (i.e., fits the observed reality better), and the science gains maturity. Scientific research involves continually moving back and forth between theory and observations. Both theory and observations are essential components of scientific research. For instance, relying solely on observations for making inferences and ignoring theory is not considered valid scientific research (Anol Bhattacherjee, 2012).

Types of Scientific Research

Scientific research projects can be grouped into three main types: explorative, descriptive, and explanatory.

Explorative Research

Explorative research is often conducted in the field of new investigations, where the research objectives are: (1) to know the magnitude or extent of a particular phenomenon, problem, or behavior, (2) to generate some initial ideas (or "premonitions" - "hunches") about the phenomenon, or (3) testing the feasibility of conducting more extensive research on the phenomenon. For example, if citizens are generally dissatisfied with government policy on economic recession, explorative research can be directed at measuring the degree of dissatisfaction of citizens, understanding how such dissatisfaction is manifested, such as the frequency of public demonstrations, and the alleged causes of such dissatisfaction, such as ineffective government policies in the face of inflation, interest rates, unemployment, or higher taxes.

Such research may include checks on publicly reported figures, such as forecasts of economic indicators, such as gross domestic product (GDP), unemployment index, and consumer prices, archived by third party sources, obtained through interviews of experts, leading economists, or a principal government official, and/or derived from studying historical examples in dealing with similar issues. This research may not lead to a very accurate understanding of the problem of the target, but may be useful in encompassing the nature and extent of the problem and become a useful precursor for more in-depth research.

Kimberly Winston makes a metaphor for defining exploratory research. When we are children, we have a natural curiosity about the world around us, we ask questions like this; why the sky is blue? why birds can fly? Questions like these are often the basis of explorative research because it expresses our desire to understand the world around us. **2]**

Exploratory research is the examination of the subject in an effort to gain further insight. With exploration, a researcher begins his research with a general idea and uses research as a tool to identify issues that could be the focus of future research. See how explanatory is used in business. For example, let's say you own a bakery called The Cupcake King. If you want to increase sales but you do not know where to start, you may use explanatory methods to find solutions to improve certain factors. It is important to note that the purpose of exploratory research is not to get a definite answer, as is the case with math problems. For example, you know that no matter how many ways you look at 1 + 1 math problems, the answer is always 2.

There are several methods used in exploratory research. Researchers may use either primary or secondary research or a combination of both types of research.

1. *Primary research* is data collected personally, usually from a group of people who gather specifically for research. The data from primary research are collected through interviews, focus groups, customer surveys, or any way that researchers can get feedback. For example, social media and blogs are a great way for business owners to get feedback from customers.

2. *Secondary research* is the analysis and synthesis of primary research compiled on the previous date. Secondary research can be collected from marketing research data, magazines, old reports, or other sources where relevant information has been stored.

Exploratory research is defined as a preliminary study that presents ideas in hypothetical or theoretical form. Here, the researcher has an idea that comes from something he has observed and seeks to understand more about it. The exploratory research project is an attempt to lay the groundwork that will lead to a future study or to determine whether 'what' is observable can be explained by current theories. Most often, exploratory research lays the groundwork for further research. To make the concept of exploratory research easier to understand; imagine you are blindfolded or placed in a room without light. You are not told if there is anything in the room, but you have a suspicion there is something there. You slide slowly into the room, roaming with your fingertips until you find something.

There are two basic forms of exploratory research, research on; (1) new topic, and (2) new point of view. New topic exploration research is often unexpected and its findings are usually surprising. For example, American psychologist John Watson started behaviorism research on a new topic, the study of human behavior and learning with a sample of 'rats!' For what?

Humans have brains and rats have brains, this is a new topic that encourages interest in curiosity, is there any attempt to discover new universal laws through the learning of all the brains? Exploratory research on a new perspective can come from a new way of looking at things, either from a theoretical point of view or a new way of measuring things. For example, computers let researchers choose large populations without bothering to use random number tables; as well as old experiments involving thousands of people from all over the world, can now be done by selecting several people from the local railway station. **3]**

Explorative research often relies on techniques such as (1) secondary research - reviewing existing libraries and/or data, (2) informal qualitative approaches, such as discussions with consumers, employees, management or competitors, and (3) formal qualitative research, conducted through in-depth interviews, focus groups, projection methods, case studies or pilot studies. Explorative research results are usually not meant for decision-making alone, but to provide significant insight into a particular situation. However, exploratory research - as a qualitative research - can answer some questions, such as about; "why", "how" and "when" something happens, otherwise exploratory research cannot reveal "how often" or "how much" an event took place.

Advantages and Disadvantages of Explorative Research

Advantages	**Disadvantages**
1. Flexibility and adaptability to change. 2. It is very effective at laying the groundwork that will lead to future studies. 3. Explorative studies have the potential to save time and other resources because since the early stages, researchers have determined the type of research that deserves to be done.	1. Exploratory studies produce qualitative information that may affect the bias of interpretation of the subject under study. 2. This type of study typically uses a small sample size that may not be representative of the target population appropriately. 3. Thus, the findings of exploratory research cannot be generalized to a wider population. 4. Findings of this type of study are usually not useful for decision making on a practical level. **4]**

Descriptive Research

Descriptive research can be interpreted as a descriptive study characterized "only" as an attempt to define, describe or identify what is being researched as it is, while analytic research tries to determine why something happened like that, or how something happened "(Ethridge 2004) Descriptive research "aims to highlight current issues or issues through data collection processes that enable researchers to describe the situation more fully than is possible without using this method" (Fox, & Bayat, 2007).

Advantages and Disadvantages of Descriptive Research

Advantages	Disadvantages
1. Descriptive study cannot test or verify research problems statistically.	1. Descriptive study cannot test or verify research problems statistically.
2. The results may reflect a certain degree of bias due to the absence of statistical tests.	2. The results may reflect a certain degree of bias due to the absence of statistical tests.
3. Most descriptive studies are not 'repetitive' because of the nature of the observations.	3. Most descriptive studies are not 'repetitive' because of the nature of the observations.
4. Descriptive study does not help in identifying the cause behind the phenomenon described (John Dudovskiy, 2018).	4. Descriptive study does not help in identifying the cause behind the phenomenon described (John Dudovskiy, 2018).

Explanatory Research

Understanding and Purpose. Explanatory or explanatory research aims to explain the relationship between two or more symptoms or variables. This research is based on the basic question "why". People are often dissatisfied just to know what happened, how it happened, but also want to know why it happened. We want to explain the cause of an event. Therefore, it is necessary to identify the various variables outside the problem to confirm the cause of the problem. Therefore, exploratory research is also referred to as confirmatory research and is increasingly known as correlational research. Several definitions of correlational research are proposed as follows: correlational research involves collecting data to determine whether, and to what extent, there is a relationship between two or more calculating variables, and research using the classification of free variables is known generally as correlational research (Paul and Jeanne, 2005).

Through this explanatory research can be known how the correlation between two or more variables of the pattern, direction, nature, shape, and strength of the relationship. This coreslational study begins with an implicit or explicit question: "Is there a relationship between X and Y?" The answers to these questions can only be obtained through explanatory or correlational research. The following is an example of correlational research: "Is there a relationship between work motivation and employee absenteeism?", "Is there a relationship be

Lisa M. Given, (2008) argues, the term explanatory research implies that this study aims to "explain", not just describe the phenomenon studied. This type of research has a long history in qualitative research, especially when discussing different views on the suitability of research objectives. Traditionally, explanatory research is quantitative and usually tests the predefined hypothesis - which measures relationships among variables; data were analyzed using statistic technique. In the most narrow sense, the term exploratory research is sometimes used synonymously with experimental research, with the implication that experiments are only capable of answering causal questions.

Type of Research Explanatory. There are two main types of explanatory research, namely, (1) associate research also called covariational research, and (2) causal research. These two types are related to the meanings encountered in inter-variable relationships that may be meaningful as associations (not explaining causation) or causal relationships (explaining causation). In both coresional and causal studies, the main concern determines the direction, magnitude or strength of the relationship strength, and the forms of observed relationships.

The 'usual' type of explanatory research is as follows:

1. *Causal explanations* are an explanation of what causes some events or phenomena. Causal explanation is a very common type of explanation used when a relationship is one about cause and effect. We may say poverty causes evil, moral freedom leads to an increase in divorce or the satisfaction of enhancing achievement.

2. *Structural explanations* is an explanation of what an abstract or universal role, code or law provides satisfactory information about the relationship between the characteristics of the system and the roles that create the structure. Structural explanations are used with functional theories and patterns. A researcher makes one structural explanation using a set of interconnected assumptions, concepts, and relationships. Concepts and relationships in one theory form a mutually reinforcing system. In a structural explanation, a researcher determines a sequence of stages or introduces the essential parts that form an interlocked whole. For example, why did the health industry of the developed world be inspired by the rural poverty of the third world ?.

3. *Interpretive explanation* that aims to assist understanding. Interpretive theorists try to see the meaning of an event or practice through its placement in a specific social context. Its meaning comes from the context of a system of cultural symbols. The explanation is achieved by showing the relationship between two or more variables. The units for the analysis are called variables.

Some Criticism. There are several important criticisms of randomized experimental design as a superior research strategy for the purpose of exploratory research. ***First***, in many situations, and for some problems, it is difficult or impossible to strictly enforce the design, and many claimed RCTs are so flawed that their causal inference is questionable. ***Second***, many other types of research (ranging from quasi-experiments, to causal modeling, to qualitative approaches) can establish causal conclusions, not with certainty (no method can do this) but no doubt. ***Finally***, the causal model assumed by most RCT supporters and by quantitative researchers, including Indonesia, known as the "deductive-nomological model" or "order model", has been the object of continuing criticism in both the philosophy of science and social research. Since the collapse of logical positivism, which is very close to this model, the alternative view of causation (often identified as "realist") has received great attention.

Advantages and Disadvantages of Explanatory Research

Advantages	**Disadvantages**
1. Because explanatory research almost always uses a quantitative approach, it is easier for researchers to confine research	1. The shortcomings of this research can start from the researcher's lag because "wrong" set the theory that cannot

issues to research problems as they are aided by appropriate theoretical decisions, let alone the same theory being breakdowned into concepts and variables that are more easily measured. 2. Researchers are also easier to set research goals, as well as guiding researchers to follow the flow of research to achieve these goals. 3. The researcher can determine the population and the sample according to the research objectives. Moreover, there are valid sampling techniques available. From the sample that researchers can generalize the results of research on the population in large numbers. 4. Researchers more easily compile questionnaires based on indicator that comes from research variables, easier to collect data from large number of samples, let alone technically questionnaire structure is closed option to facilitate the choice of respondents' answers, consequently the data more easily categorized and tabulated in the form of scores and index so as to facilitate testing statistically. 5. Researchers can interpret the results of research based on the index and scores of respondents' answers, and interpretation of researchers generally close to the truth of the reality of the object under study.	"accommodate" the problem that will serve as the focus of research. 2. The mistake of choosing a theory can affect the impact of follow-up is the error set variable, indicator, validity and reliability in the preparation of the questionnaire so that researchers lead to collect data that are not needed in accordance with the purpose of research. 3. The researcher can determine the wrong population and sample which is not appropriate sampling technique, due to sample error, the researcher can make generalization of biased research result, far from the research objectives that have been determined. 4. Researchers can be wrong in determining statistical tests that are not in accordance with the nature of the test, additional can use the test statistic is not strong enough to explain the relationship between research variables. 5. The conclusions of the study are summarized because the researcher's review is limited to the data obtained from the questionnaire, this is because the researcher does not have the opportunity to make interpretations outside of the respondent's answers in the questionnaire. 6. Quantitative research results may be statistically significant but often not socially significant. Some things that are numerically incorrect or must be

6. Researchers are also easier to display the results of research briefly and clearly based on the interpretation of the selected statistical exam. 7. The objectivity of the results of this study is assured because the reality of the object of research can be calculated and measured numerically, meaning the results of research is not easily misinterpreted. Because of that objectivity, researchers and other research can do re-research with the same quantitative method, in the same situation, so as to allow comparison of the results are not too different (read: there is a percentage of confidence level and coefficients of wrong measurement) 8. Research work is very helpful because the entire process and stages of the study arranged in a planned manner so that research can be completed in accordance with the time targeted. Instead, researchers can make predictions about proposed improvements and other research plans in the future. 9. Causal-causal explanatory studies can play an instrumental role in identifying the reasons behind various processes, including helping researchers to assess the impact of changes on the norm, the reality process at which time will come. 10. Another advantage of this study is that it can offer replication benefits in	numerically correct can lead researchers to draw inaccurate conclusions. 7. It is difficult to reach the right conclusions based on the findings of causal research. This is due to the impact of various factors and variables in an uncontrollable social environment. In other words, researchers do not easily draw conclusions with a high degree of certainty. 8. In some cases socially there is a correlation between variables but statistically shows no correlation, and vice versa, socially there is no correlation but statistically, there is a correlation between variables; if it happens like this then researchers tend to draw conclusions with a false interpretation. 9. The accuracy level of this research, among others, lies in the large number of samples, the larger the sample approaching the population, the results of the study are predicted to be closer to accuracy. However, the sample size affects technical factors such as longer time costs and research. 10. The results of this study provide narrow and unrealistic information by using sample sizes that capture only a small portion of the concepts studied. This provokes the question of whether research really measures what the researcher claims, consequently

case of error. 11. This type of research is associated with a greater degree of internal validity due to the selection of highly systematic research objects. 12. Researchers easily eliminate the bias by the researcher's perspective, therefore the researcher can be controlled to keep the distance with the research subject, let alone the population and the unknown sample i so that the research result is considered valid. 13. About the method, generally through a process with a high procedure so it is very easy to replicate because it has high reliability. 14. The use of survey instruments that collect data from all program stakeholders in this study can improve the problem of qualitative research that collects data only from a group of people who may not necessarily master the research problem. **5]**	quantitative research can be said to have low validity. 11. In some cases, research often occurs in an "unnatural" setting, this is because researchers create an artificial environment to control all relevant variables. So how can researchers be sure that the results they get in the lab will also apply in the real world?

Research Approach

Peirce outlines the scientific method as coordinating three types of conclusions in a cycle that aims to resolve a researcher's choice of doubt. Sometimes referred to as research approaches, namely:

1. Deductive research approach
2. Inductive research approach
3. Abductive research approach.

The so-called three "approaches" are often referred to as "research reasoning," argumentation, or whatever the name describes the "way of thinking" of the researcher. For example a deductive approach is used to test the validity of assumptions (or theory/hypothesis) research (quantitative research) (remember: test theory), then inductive approaches contribute to the emergence of new theories and generalizations (remember: construct theory); while the abduktif approach is used to explain the 'surprising new facts' or 'puzzles' from the results of the study (Bryman & Bell, 2015).

Deductive Research Approach

Deductive reasoning, or so-called deductive logic, logical deduction; is the process of reasoning from one or more statements (premises) to reach certain logical conclusions (Sternberg, 2009). Deductive reasoning runs in the same direction as the conditional and connects the premise to the conclusion. If all premises are true, the terms are clear, and the rules of deductive logic are followed, then the conclusions reached are certainly true. Deductive reasoning (top-down logic) contrasts with inductive reasoning (bottom-up logic). With deductive reasoning (usually in quantitative research) a conclusion is achieved reductively by applying a 'general statement' that determines the overall discourse, and from which the researcher narrows the range of considerations to only the remaining conclusions.

In inductive reasoning (usually in qualitative research), a conclusion is reached by generalizing or extrapolating from certain cases to 'general statements', ie there is epistemic uncertainty. However, the inductive reasoning mentioned here is not the same as the induction used in mathematical proof - mathematical induction is actually a form of deductive reasoning. The deductive reason differs from the abductive reasoning with the reasoning direction relative to the conditional. Deductive reasoning goes in the same direction as conditions, whereas abductive reasoning moves in the opposite direction (Sternberg, 2009).

With deductive reasoning, a researcher will take the general theory or idea, test it, and move through a series of ideas to come to a certain conclusion (theory, proposition, concept, variable, operational definition). For example, every animal that eats a mouse is a cat; Plow to eat rats, then plow is a cat. The purpose of deductive reasoning is to arrive at a valid reasoning chain, where every statement should be testable, but this example of deductive reasoning may apply but it does not make sense.

Larry Sanger, (2016), says briefly, deductive reasoning is valid, if the premise is true, then the conclusion must be true. In other words, a good deductive argument is deductive, meaning that the building "forces" the conclusion to be true. Deductive mathematical reasoning, successful deductive arguments are called evidence in some contexts (eg, in mathematics and logic). The classic example, "Socrates is human, the man is always cruel, because Socrates is human, so Socrates is also cruel." In deductive reasoning, researchers can assess the impact of labor migration in Europe, for example proposing the formation of multicultural teams in the UK Researchers can propose a hypothesis " work in Europe contributes to the formation of multicultural teams in the UK ".

Inductive Research Approach

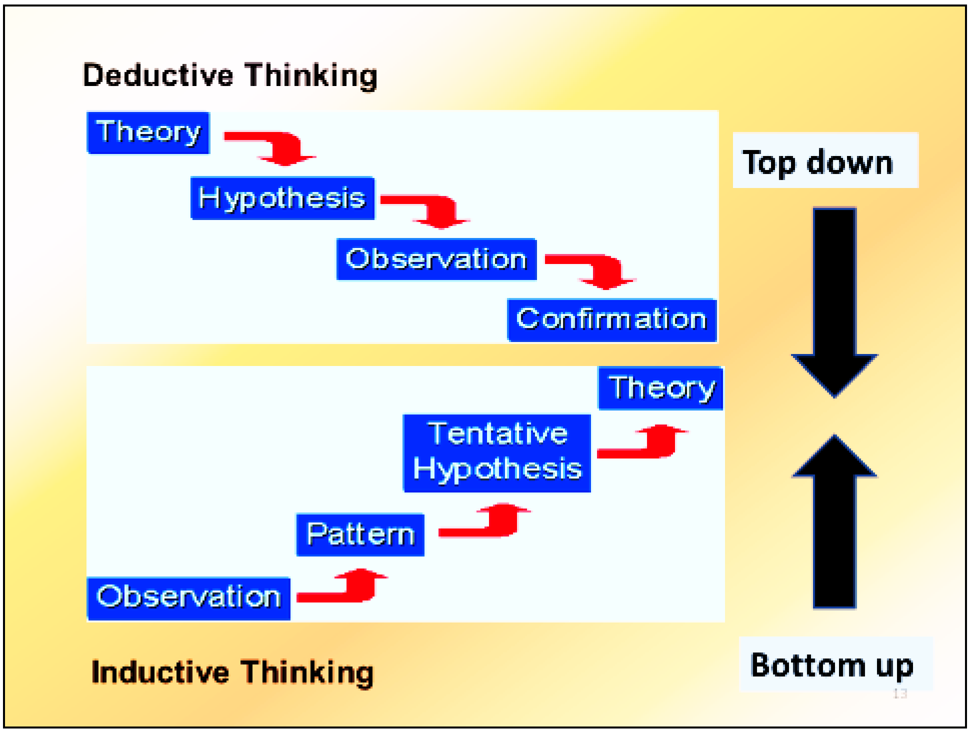
Alternatively, the inductive approach does not involve hypothesis formulation. This approach begins with questions and research objectives and objectives that need to be achieved during the research process. Inductive reasoning (as opposed to deductive reasoning or abductive reasoning) is a method of reasoning in which the premise is seen as strong evidence to prove the correct conclusion. While the conclusion of the deductive argument is certain, the truth of the inductive argument's conclusion is possible, based on the evidence given.

Many textbooks define inductive reasoning as a derivative of the general principles of specific observations, although some sources disagree with this use. The philosophical definition of inductive reasoning is more nuanced to the simple development of a particular case/individual to a broader generalization. In contrast, the premise of an inductive logical argument indicates some degree of support (inductive probability) for conclusions. That is, there is truth but it can not be ascertained. In this way, it is possible to move from general statement to individual case (for example, statistical syllogism (Copi; Cohen; Flage, 2007).

A simple example of inductive reasoning might begin with observations like "All the cows I've seen - the tail is visible." One might assume that all cows should be seen. This is not really the case, but given the information, someone may be forgiven for thinking about it. The next step in this logic may involve attempting to find things that deny the assertion that all the cows are seen, as might be done by asking others if they have seen an invisible cow.

Inductive reasoning is usually seen in science when people want to understand a series of observations. Isaac Newton, for example, is famous for using inductive reasoning to develop the theory of gravity. Using observation, one can develop a theory to explain the observations and seek evidence for the theory. As can be seen in the example of the cow above, one of the main disadvantages with inductive reasoning is that it depends heavily on observation, and when the observation is incomplete, the researcher can formulate the bad result. An example of inductive reasoning, some people in the ancient world believe that meat spontaneously causes maggots. Their conclusion is based on the observation that if the flesh is abandoned then the maggots will appear on it. Some researchers decided to test this theory by asking whether the meat that was left did not have maggots? By processing the meat in various containers in addition to fully exposed meat, the scientist realizes that the maggots are actually the eggs laid by the flies.

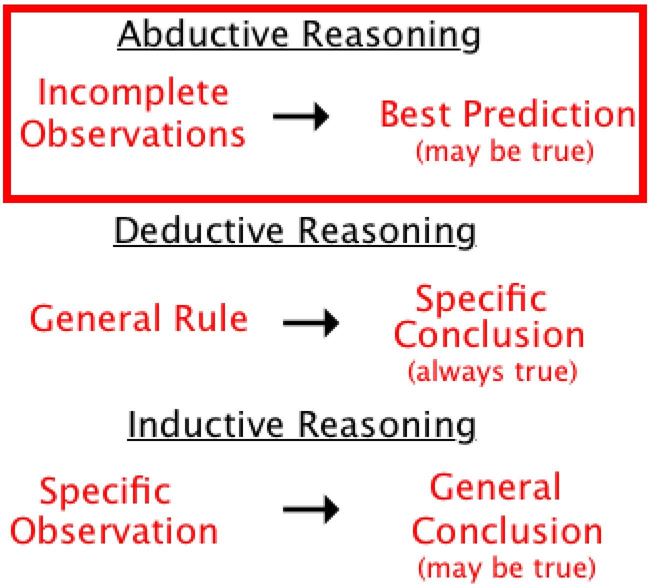
Larry Sanger, (2016), argues that inductive reasoning will occur if all premises are true, then the conclusions may be true. The more probable truth is that the stronger the inductive argument becomes. Statisticians are very useful because it allows us to know how sure we should get conclusions based on data; they actually measure the strength of the inductive argument. Most scientific reasoning is inductive. The classic example, "The sun has risen every day in human memory, therefore, perhaps, the sun will rise again tomorrow." (Maybe the earth or the sun, will be evaporated by dark planets or invisible cosmic rays or what have you naturally overnight.)



This last chart shows that there is a close relationship between quantitative and qualitative research based on deductive and inductive approaches. Variations of this model are also later "manipulated" into mixed approaches (mixed method).

Abductive Research Approach

Abductive reasoning, also called an abductive approach to overcome the weakness of the deductive and inductive approach. In particular, deductive reasoning is criticized for lack of clarity in terms of how to choose the theory to be tested through the formulation of hypotheses. Inductive reasoning, on the other hand, is criticized because "no amount of empirical data will allow the creation of a theory". Abductive reasoning, as a third alternative, overcomes this weakness through the adoption of pragmatic perspectives. The figure below illustrates the main differences between abductive, deductive and inductive reasoning:



Abductive reasoning is similar to a deductive and inductive approach, as the way it is applied to draw logical conclusions and construct theory. In abductive approach, the research process begins with 'surprising facts' or 'puzzles' and the research process is expected to present an explanation of the new facts. This 'surprising fact' or 'puzzle' can arise when a researcher meets an empirical phenomenon that can not be explained by the various theories. When following the abductive approach, researchers sought to select the 'best' explanation among many alternatives to explain the 'surprising fact' or 'puzzle' identified at the beginning of the research process. In explaining the 'surprising fact' or 'puzzle', researchers can combine reasoning, numerical and cognitive. **6]**

Indeed, the abductive concept originally introduced by Aristotle was the American philosopher Charles Sanders Peirce (1839-1914) who developed this approach into an explicit inference theory. Pierce proposed that the traditional mode of inference - induction and deduction - must be supplemented by a third mode - abductive - which he claimed to be qualitatively different from the other two. This Pierce approach can be understood by example of the study of oral interactions. According to Pierce, the study of oral interactions is generally explained by one of two ways, communication theory or explicit interaction theory, these two ways are used as a basis for analyzing actual examples of conversation; where conversation data is taken as the starting point of a conversation to formulate new theoretical concepts and rules. The first "deductive" model can be found in most linguistic pragmatic approaches, whereas the second "inductive" model is more dominant in ethnomethodological conversation analysis, but for practical scientific studies, researchers cannot draw conclusions based only on pure deduction or induction. The essence of any scientific process is the inferential step of some fact which may have puzzled researchers from the outset when setting out some theoretical hypotheses to explain later.

Deductive

1. Rules: all seeds of this bag are white
2. Case: This bean comes from a white bag
3. Result: this bean is white

Inductive

1. Case: This bean comes from a white bag
2. Result: this bean is white
3. Rules: all seeds of this bag are white

Deductive reasoning, the drawing of conclusions begins with regard to the 'rule' (read: in explanatory/quantitative research is 'theory', from the 'rules' the researchers pay attention to specific cases (preconditions) and then draw conclusions based on 'results' (observation). this involves generalization, ie the reasoning of certain examples and then linked back to the 'rule' or 'law' or common patterns. While in inductive reasoning, the researcher will look at case by case to draw results or conclusions and then be confirmed on 'rules', but researchers can think critically about certain unique cases, for example, we may find that only the seeds on the top of the bag are white, while the peanut seeds on the bottom of the bag are brown.

Abductive

1. Rules: all seeds of this bag are white
2. Result: this bean is white
3. Case: This bean comes from a white bag

Abductive reasoning draws conclusions by case with regard to the premise of rules and outcomes. A researcher who draws conclusions based on abduction feels less confident with deductive and inductive reasoning. Say, white beans may come from a mixed bean bag or from a bag that no longer exists. Pierce mengembangkan penalaran abduktif sebagai proses untuk mendapatkan pengetahuan baru.

It can be argued that, abductive reasoning is also called 'abduction', relying on; (1) abductive inference, or (2) 'retriduction'; as a logical conclusion that begins with observation and then researchers try to find the simplest explanation and the most likely. In abductive reasoning, unlike deductive reasoning, the premise does not guarantee conclusions. A researcher can understand abductive reasoning as the best conclusion or explanation (Campos, 2011, Walton, 2001). For example, in the 1990s, as computerization grew strongly, the field of legal studies began to think about the concepts of crime arising from artificial intelligence, including sparking renewed interest in kidnapping (Flach, 2013).

Larry Sanger (2016) says that abduktif reasoning is an important inductive reasoning variation or commonly referred to as inference to get the best explanation. Generally, researchers call it 'inductive reasoning variations' because they fit the definition, although sometimes philosophers distinguish both (deductive and inductive) as very distinctive types, for example, because not all inductive arguments directly use explanations. When scientists, detectives, or doctors or ourselves, when very experienced do something that at any time can produce a model that can explain the total amount of data better than other models, then we can draw the conclusion that the model is true, then we actually have used the abductive approach.

	Deductive	Inductive	Abductive
Logical	In deductive conclusion, if all premises are true, the conclusion must also be true.	In an inductive conclusion, all premises can be used to generalize inferences that will not always be true.	In an abduktive context, the premises can be accessed to produce the details that can be suppressed
Generalization	Attracts generalizations from the general to the particular.	Draws generalizations from specific to common.	Generalization is derived from the interaction between the specific and the general
Data usage	Data usage Data released to propose propositions or hypotheses related to existing theory.	Data copied to include phenomena, identify themes and create conceptual frameworks	Data used to explore phenomena, identify, and create, find information in this context.
Theory	Verification or 'falsification' of theory. Forgery'	Generalization of theories to construct 'new' theories	Generalization of theory or modification to existing theory - appropriate theories to construct new 'theories' or available theories exist.

Saunders, (2009)

In an abductive approach, the research process is devoted to explaining 'incomplete observation', 'the surprising fact' or 'puzzle' that was determined from the beginning of the study. Referring to the research topic on the impact of labor migration on the establishment of multicultural teams in the UK; You can observe that labor migration in Europe actually reduces the degree of cross-cultural differences within groups in the UK. Then, your study may be devoted to explaining this phenomenon using qualitative and/or quantitative data collection methods and analyzed in an integrated manner. The following table illustrates the main differences between deductive, inductive and abduktive research approaches in terms of logic, generalization, data usage and theory (Saunders, Lewis & Thornhill, 2012). ***

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