UNIT 1 INTRODUCTION TO RESEARCH IN GENERAL

Contents

1.0 OBJECTIVES

- To introduce the students to the basics of research methodology.
- To provide them with the basic conceptual tools for scientific research.

1.1 INTRODUCTION

M S Sridhar understands research as "systematic, controlled, empirical, critical and self-correcting investigation of hypothetical propositions about the presumed relations among natural phenomena,": i.e., Systematic & controlled empirical self-correcting research is a combination of both experience & reasoning and must be regarded as the most successful approach to the discovery of truth (particularly in natural sciences). Since it involves experience and critical reasoning, it may be regarded as the "most successful approach" to the discovery of truth. Further, we can claim that in a general way, everyone does research, but they do not write it down. Without trustworthy and tested published research available we are dangerously lost in the experience, opinions and hearsay and such a data cannot be used for further study.

In short research methodology may be defined as the "science of studying how research is done scientifically (Sridhar)." It is a way to systematically solve the research problem by logically adopting various steps. Proper methodology, employed in research, helps to understand not only the products of scientific inquiry but the process itself. Such a research methodology aims to describe and analyze methods, throw light on their limitations and resources, clarify their presuppositions and consequences, relating their potentialities to the twilight zone at the 'frontiers of knowledge.' Thus research methodology provides the tools for conducting serious and useful research. It is applicable to all fields of science, including humanities and philosophy. In this unit we study further about research in general, the tools used for it and the methods employed for doing research. In the concluding part, we focus on the outcome of the research in terms of report or paper, which further advances the useful human knowledge.

1.2 RESEARCH IN GENERAL

It may be proper to begin by saying what research is not. Definitely it is not mere information gathering. It is not even mere shifting of facts from one source to another. Further it is not merely rummaging for information, which cannot be properly made use of. Positively stated, research is the systematic process of collecting and analysed information to increase our understanding of the phenomenon under study. It is the function of the researcher to contribute to the understanding of the phenomenon and to communicate that understanding to others (Venkataram 2010).

Research is thus about understanding an issue or asking and answering a complex question or solving a problem. So, to start with, we need to identify an issue, question, or problem. Then we need to discuss with people who want or need your study. Listening to their suggestions and problems will help us. Further, we need to find out what's already known about it. For this talk with experts and/or read their reviews and the other original research on the topic by different scholars. Then we need to plan, budget and proceed with our study accordingly. Do not exceed the time limit and the budget of our planned study. Then we need to conduct research, record our findings in writing and submit it for assessment. Publication in quality journals enhances the worth of the study and makes it available to larger audience. In academic circles the slogan "publish or perish" still dominates.

It helps to have a good supervisor, good colleagues, and/or knowledge or practical experience of and affinity for a topic (See Hopkins 2010). It is essential to read journal articles to find out what's already known. Many authors also often point out topics for future research. This prevents doing research on an area already explored and thus prevents wasting valuable time and effort. It may be emphasized that most serious research projects are supposed to be original investigations. Either you obtain new data or information about a phenomenon. Or you reach a novel conclusion and try to publish it. Briefly we can say that the distinct characteristics of research is that it originates with a concrete question; requires clear articulation of a goal and a specific plan for proceeding. Usually research divides a principal problem into more manageable sub-problems.

Benefits of Research Methodology

Sridhar (2010) formulates the following benefits of adequate research methodology both for the researcher and for the body of useful knowledge.

1. Advancement of wealth of human knowledge in any field.

2. Provides tools of research to look at life objectively.

3. Develops a critical and scientific attitude, disciplined thinking or a bent of mind to observe objectively (scientific deduction & inductive thinking); Skills of research will pay-off in long term particularly in the μage of information (or too often of misinformation)

4. Enriches investigator and their practices; it provides opportunity to study a subject in depth; Enable us to make intelligent decisions; Understand the problem which no other kind of work can match

5. As consumers, research output helps to inculcate the ability to evaluate and use results of earlier research with reasonable confidence and take rational decisions

6. Doing research is the best way to learn to read and think critically and creatively.

Check Your Progress I

Note: Use the space provided for your answer

1. What do you mean by research?

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2. Give any three benefits of research methodology.

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1.3 RESEARCH CIRCLE

Research is guided by the specific research problem, question or hypothesis. It accepts certain critical assumptions. It definitely requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research. This leads to further clarification of the question and the proposed solutions. Thus research is, by its nature, cyclical or, more exactly, spiral or helical. Research originates with a question: Examples: Are philosophers accepted well in the society? What do street children eat in a day? Why do poor people appear happier? What is the relationship between belief in God and good moral life? It requires clear articulation of a goal: What problem do you want to solve? Moral degradation? Deepening of faith in God? Change of behaviour? Praying more often? Building up an adequate world-view?

Further, good research requires a specific plan. It is not groping in the dark to find a solution. In fact, it is a planned discovery with outlined steps for tacking the problem. It implies a design of study specific to get relevant data needed. In a good research we need to divide problem into sub-problems. The main problem is divided to into more manageable problems that will answer the main problem. ("Manage the unavoidable and avoid the manageable"). Example: Main problem: "How do you go from Pune to Delhi?" Sub-problems: What are the ways to go there? What is the most convenient transportation? How much will it cost to travel by these routes? How long will the trip last? This, in turn, is guided by specific research problems, questions and hypothesis. A hypothesis is a logical supposition, a reasonable guess, an educated conjecture that provides a tentative explanation for the phenomenon under investigation. It can also provide information in resolving the specific problem and in the process, the main research problem. Ex. If you switch on the lamp and it does light what is your reasonable guess as to the reason why it does not light?

A good research accepts certain critical assumptions. Assumptions are similar to axioms in geometry – self –evident truths -the *sine non qua* of research. They must be valid for the research to be meaningful. For example, if a research wants to evaluate the knowledge gained from a

nutrition education class, one assumption would be regular attendance to the class of participants. A good research requires collection and interpretation of data to resolve problem initiated. Data collected based on objectives or research questions. Data collected becomes meaningful when it is interpreted correctly. Methodology of the project controls how data are to be collected, arranged, synthesized and interpreted. A good research by nature is cyclical, or spiral or helical. It follows logical developmental steps as follows: Questioning mind asks "why?" One question becomes the problem. Later, problem divided into simpler sub-problems. Then preliminary data gathered. It may be that data point to alternative solution. So further data collected more systematically. Then the data are processed, leading to the possible discovery. This will enable the researcher to see if the hypothesis supported or not. If the hypothesis is proved wrong, modifications are made to it and the process repeats itself, till a satisfactory hypothesis is formulated. Thus good research process.

Remark on the credibility of materials used in research: It is important for us to know the reliability of the materials that we base the data or information used in our research. Every materials we get should not be used, since they may be prejudiced or motivated. Some significant questions to find out the reliability of the already existing research material are: In what source did you find the article? Was it reviewed by experts in the field before publication? Does the article have a stated research question or problem? Or, can you determine the focus of the work? Does the article describe the collection of data, or does it synthesize other studies in which data were collected? Is the article logically organized and easy to follow? Does the article contain that outlines and reviews previous studies? In what way is this relevant to the research problem? Are the procedures clear enough that you could repeat the work and get similar results? How were the data collected and how were they analyzed? Do you agree with what was done? Do you agree with the interpretation of results? Reflect on the entire article. What, for you is most important? What are interesting? What are the strengths and weaknesses? Will you remember the article in the future?

1.4 TOOLS OF RESEARCH

A tool is a specific mechanism or strategy that researchers use to collect, manipulate or interpret data. Not to equate tools of research with methodology. A methodology is the general approach that a researcher takes in carrying out the research process. Six general tools of research are: Library and its resources (most useful for philosophy students), Computer and software, Techniques of measurement, Statistics (The program SPSS is recommended for research based on statistics), The human mind (this is the strength of philosophy students), Language.

The library

For a philosophical research the library is always the starting point. Here the following will be very beneficial: Referring to the Card catalogue, Browsing through Indexes and abstracts, Consulting the Reference librarian, if s/he is accessible. Browsing the shelves gives a first hand knowledge of the books and journals available on the topic of research.

Computer and Software

In today's context, good research cannot be done without adequate computer facilities. Computer facilitates not just writing, but collecting data (internet, online journals, libraries, etc.) and

processing them. Some software packages for qualitative searches are NVivo, Q-Method, WEFT. For quantitative research, some of the softwares used are: Excel, XLSTAT, SAS and SPSS. So for any research today adequate and appropriate use of internet and computer is a necessary.

Techniques of Measurement

Measurement may be done in the laboratory or in the world outside. Interviews serve a useful function. Measurement is limiting the data of any phenomenon- substantial or insubstantial – so that those data may be interpreted and compared to acceptable qualitative or quantitative standard. So the techniques used in measurement are of vital importance for the result we arrive at. Validity and reliability of measurement instrument is to be tested. Validity – extent to which the instrument measures what it is supposed to measure. Reliability – the consistency with which a measuring instrument yields a certain result when the entity being measured has not changed. Both validity and reliability reflect the degree to which we may have error in measurements.

Statistics

In order to process the result from data collected, statistical processing & analysis are to be done, especially in cases of large sample. Statistical methods are helpful to test the accuracy of the results obtained. Today we can better do it using statistical softwares. So a basic knowledge of statistics is necessary for any researcher.

The human mind

Truly, the strategies used by the human mind to discover the unknown helps us in testing the hypothesis, which could become the answer to the question to be answered. **Deductive logic**: Reasoning that begins with a premise (assumptions, widely accepted "truths" then to the conclusion; useful for generating hypothesis and testing theories. **Critical thinking:** Involves evaluating information or argument in terms of accuracy and worth; it may involve: **Inductive reasoning:** It begins with an observation from where conclusions are drawn ; observe sample and draw generalization to the population. **Scientific method:** Method where insight into the unknown is made by 1) identifying a problem that defines the goal , 2) states the hypothesis that when confirmed, resolves the problem , 3) gathering data relevant to the hypothesis, 4) analyzing and interpreting data to see if data supported the hypothesis nor not; also uses both deductive and inductive reasoning.

Language for adequate expression

Proper use of language enables us not only to communicate but also to think more effectively. Clear and concise use of language in writing is important in research. Writing down ideas helps the investigator to get clarity of mind. This, in turn, is useful to organizes thoughts systematically to give the proposed answer to the readers. Writing down the answer is helpful in detecting gaps and logical flaws in thinking in formulating the final answer.

Check Your Progress II

Note: Use the space provided for your answer.

1. Name six tools of research.

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2. What are some softwares used in research today.

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1.5 METHODS: QUANTITATIVE OR QUALITATIVE

The method used in research may be quantitative or qualitative. Qualitative methods are often required. It may be remembered that often you arrive at an answer by applying logic (= common sense?) and skepticism to your knowledge and to the information you gather. So let us be wary of conventional wisdom and your own prejudices.

Quantitative method in Research that with the quantities of things and that involves the measurement of quantity or amount. With quantitative method we gather data with an instrument, such as a stopwatch, a blood test, a video analysis package, or a structured questionnaire. Here we derive measures or variables from the data, then investigate relationships among the variables. Here testing of a hypotheses becomes easy. The error of measurement are crucial since we know that almost all measures have possibility of errors. Such errors affect the relationship between measure, leading to errors in validity and reliability of the final result. So a pilot study to investigate error can be carried out first.

Qualitative research deals with the quality, type, or components of a group. It is usually exploratory in nature and uses procedures such as in-depth interviews and focus group interviews to gain insights and propose solutions to problems posed by the investigator. With qualitative methods we gather information or themes from texts, conversations or loosely structured interviews, then we try to articulate a coherent story. The open-ended nature of these methods allows for more flexibility and serendipity in identifying factors and practical strategies than the formal structured quantitative approach. It is possible that in qualitative research, the direction of the research may change mid-stream. Software such as NVivo, Q-Method or WEFT can be of help in qualitative analysis.

Other formal procedures that enhance trustworthiness of the result are: **Triangulation** – Triple checking of a hypothesis that aims for congruence of information from various sources. **respondent validation**: Here the respondent is asked check the researcher's hypothesis in a scale of strongly agree to strongly disagree. **Peer debriefing**: colleagues of the investigator or or experts can be asked to check the analysis. **Hybrid or mixed method:** Here we may analyze a sample of cases first qualitatively. Then we may code information into values of variables to make inferences about a population quantitatively.

Qualitative methods applied to a sample often result in a small sample size because (1) subjects are hard to get, the interviews are too time consuming, or (2) the researchers dislike the idea of large samples. But a study with a small sample can adequately characterize only strong associations (large effects) in a population. So, these small-scale qualitative studies are not

definitive for a small or trivial effect, which may be actually important in the hypothesis formulated. Furthermore, open-ended inquiry is equivalent to assaying many variables, so there is a high risk of finding a spurious association. It may be emphasized that if the sample is small, the spurious association will be strong. Therefore, small-scale qualitative studies are not definitive even for a moderate or large effect. So based on our reasonable guess from qualitative methods, we may use quantitative methods or surveys to reinforce our answers. Such a combined method is more useful. The conclusion is: when using qualitative methods to generalize to a population, you need a large sample to characterize small effects. So a hybrid of qualitative and quantitative may be more profitable for some research.

Concluding Remarks

Qualitative research methods have been developed and refined through attempts to understand the patterns and associations in human behaviour and relationships in disciplines such as sociology, anthropology and educational psychology. However, they also formed the basis of the natural sciences where the natural world was initially described and chronicled by narrative researchers. Qualitative and quantitative methods are not mutually exclusive, rather, different degrees of mixing of the methods occur as the following examples illustrate. Both qualitative and quantitative research is fundamentally concerned with discerning similarities and differences in what they choose to observe. New insights and models are suggested by the nature of these contrasts and approximations, whether they are measured in numbers or described in words. However, each mode of research, each way of looking at the world, creates different modes of knowing and understanding.

Adding qualitative research methods to the quantitative methods used in general practice research will allow the development of a research base for the discipline that matches its practice and its values, and opens up new questions to research. Qualitative research often demands an examination of the assumptions behind a research question and the influences on our thinking. This process increases our understanding of the forces shaping all our research including personal experience, political constraints and academic acceptability. This can clarify the limitations of research as well as leading to further research questions. (Griffiths and Marinker 1996)

1.6 THE PRODUCT: RESEARCH REPORT OR PAPERS

A major goal of research is prepare several research papers based upon the studies undertaken. Written and oral communications skills are probably the most universal qualities sought in a good research.

General form of a research paper

An objective of organizing a research paper is to allow people to read your work selectively. When I research a topic, I may be interested in just the methods, a specific result, the interpretation, or perhaps I just want to see a summary of the paper to determine if it is relevant to my study. To this end, many journals require the following sections, submitted in the order listed, each section to start on a new page. There are variations of course. Some journals call for a combined results and discussion, for example, or include materials and methods after the body of the paper. The well known journal Science does away with separate sections altogether, except for the abstract. (Caprette) Your papers are to adhere to the form and style required for the

Journal of Biological Chemistry, requirements that are shared by many journals in the life sciences. These general guidelines are to be followed in any written reports, except when the guides or editors give explicitly different instructions.

- To make a paper readable
- Print or type using a 12 point standard font, such as Times, Geneva, Bookman, Helvetica, etc.
- Text should be double spaced on 8 1/2" x 11" paper with 1 inch margins, single sided
- Number pages consecutively
- Start each new section on a new page
- Adhere to recommended page limits, set by the guide.
- Mistakes to avoid
- Placing a heading at the bottom of a page with the following text on the next page (insert a page break!)
- Dividing a table or figure - confine each figure/table to a single page
- Submitting a paper with pages out of order
- In all sections of your paper
- Use normal prose including articles ("a", "the," etc.)
- Stay focused on the research topic of the paper
- Use paragraphs to separate each important point (except for the abstract)
- Indent the first line of each paragraph
- Present your points in logical order
- Use present tense to report well accepted facts - for example, 'the sky is blue.'
- Use past tense to describe specific results - for example, "In 1783 Kant wrote the Prolegomena to any Future Metaphysics to summarise his main views."
- Avoid informal wording, don't address the reader directly, and don't use jargon, slang terms, or superlatives
- Avoid use of superfluous pictures - include only those figures necessary to presenting results

In any written report or paper the following divisions are to be made scrupulously.

Title Page: Select an informative title as illustrated in the examples in your writing portfolio example package. Include the Full name(s) and address(es) of all authors, the name(s) of guide(s) and date submitted.

Abstract: The summary should be two hundred words or less. And normally it should be limited to one paragraph. The purpose of abstract is to introduce the main findings of the report very briefly to an interested reader.

Introduction: The purpose of an introduction is to acquaint the reader with the rationale behind the work, with the intention of defending it. It places the work in a theoretical context, and enables the reader to understand and appreciate your objectives.

Materials and Methods: There is no specific page limit, but a key concept is to keep this section as concise as you possibly can. People will want to read this material selectively. The reader may only be interested in one formula or part of a procedure. Materials and methods may be reported under separate subheadings. The objective of this section is to document all

specialized materials and general procedures, so that another individual may use some or all of the methods in another study or judge the scientific merit of the work. It is not to be a step by step description of everything the investigator did, nor is a methods section a set of instructions.

Results: The page length of this section is set by the amount and types of data to be reported. Continue to be concise, using figures and tables, if appropriate, to present results most effectively. See recommendations for content, below. The purpose of a results section is to present and illustrate the findings. Make this section a completely objective report of the results, and save all interpretation for the discussion.

Discussion: The objective in this section is to provide an interpretation of the results and support for all of the conclusions, using evidence from the experiment and generally accepted knowledge, if appropriate. The significance of findings should be clearly described. Interpret the data in the discussion in appropriate depth. This means that when we explain a phenomenon we must describe mechanisms that may account for the observation. If the results differ from the original expectations, explain why that may have happened. If the results agree, then describe the theory that the evidence supported. It is never appropriate to simply state that the data agreed with expectations. We need to elaborate. Decide if each hypothesis is supported, rejected, or if we cannot make a decision with confidence. Do not simply dismiss a study or part of a study as "inconclusive." Normally, an inconclusive study is not really a scientific study.

Bibliography or Literature Cited: List all literature cited in the paper, in alphabetical order, by first author. In a proper research paper, only primary literature is used (original research articles authored by the original investigators). Be cautious about using web sites as references - anyone can put just about anything on a web site, and we have no sure way of knowing if it is truth or fiction. If we are citing an on line journal, use the journal citation (name, volume, year, page numbers). Sometimes some of the papers may not require references, and if that is the case simply state that "no references were consulted."

Writing to communicate: Say what we mean to say clearly and consciously. Keep primary objective in writing and focus discussion accordingly. Provide overview of what will be discussed. Organize ideas from general to specific using headings and subheadings. Provide transitional phrase, sentences or paragraphs to help readers follow the flow of thought. Use concrete examples to make abstract ideas understandable. Use appropriate punctuation. Use tables and figures to present findings more adequately. Summarize what was said at the conclusion of the paper. Anticipate revision of draft of report.

1.7 LET US SUM UP

In this unit we have seen the importance of research and research methodology in fostering knowledge. We dealt with the process of research and the tools of research. Then we saw how as a scientific technique, research methodology leads to scientifically verifiable results helping us to solve problems efficiently.

Check Your Progress III

Note: Use the space provided for your answer

1. What is triangulation?

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2. What is the fundamental concern of both qualitative and quantitative research?

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1.8 KEY WORDS

Triangulation: It is a triple checking of a hypothesis that aims for congruence of information from various sources.

Qualitative Method: Methods of social research that do not depend on comparing quantities. It involve the collection and analysis of information based on its quality and NOT quantity. They are methods in which the results are primarily conveyed in visual or verbal forms.

1.9 FURTHER READINGS AND REFERENCES

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UNIT 2 ORIGINAL UNITY OF PHILOSOPHY AND SCIENCE

Contents

2.0 OBJECTIVES

- To study basic human quest for unity that has given rise to philosophy, religion and science.
- To trace the origin of human knowledge to our quest for understanding: the self, world and God.

2.1 INTRODUCTION

In order to trace the original human quest meaning through philosophy and science, we first speak of humans as the myth-making animals. Once we understand myth in a positive sense, then we can make use of our philosophical and scientific quest as emerging from our innermost sense of unity. For this purpose we use insights from the beginnings of philosophy, the Ionians who searched for the ultimate that is the basis of everything else. Then we look into the greatest scientist, ever lived, Albert Einstein, who painstakingly tried to formulate a unified theory of everything. Our argument is that there is an human quest for unity, out of which philosophy and science have emerged. So there was that original unity. Now though they follow different methods and have different goals, at the ultimate level, as human beings we use everything at our disposal – science, religion and philosophy – to open ourselves to that unity. Such a search for the original unity, in fact promotes diversity and thus makes our lives really human.

2.2 MYTH, PHILOSOPHY AND SCIENCE: ORIGINAL UNITY

As we know, humans are part of large and complex cosmic tradition going back to about 13.7 billion years, when the Big Bang gave rise to the known universe of today! About 4.5 billion years ago the solar system was formed. Further, 4.5 million years ago humans (Homo sapiens) evolved. About 20,000 years ago Neanderthals would sit around the fire at night watching starry

sky and listening to the sounds from far. They were trying to understand the world around them. They were trying to make sense of life, but more importantly, of death. How did dead people show up in their sleep, in their dreams? What could be made of their own impending deaths? In order to honor the dead person, Neanderthals buried their dead with flowers and beads. They also took care of the sick and elderly. In trying to understand death through ritual and ceremony, Neanderthals gave us their greatest gift: mythology. This endures till today though in different forms (Pandikattu 2009)

At first primitive humans thought very little about anything but immediate things. They were preoccupied thinking such things as: "Here is a bear; what shall I do?" Or "There is a squirrel; how can I get it?" Until language had developed to some extent there could have been little thinking beyond the range of actual experience, for language is the instrument of thought as bookkeeping is the instrument of business. It records and fixes and enables thought to get on to more and more complex ideas. Primordial man, before he could talk, probably saw very vividly, mimicked very cleverly, gestured, laughed, danced, and lived, without much speculation about whence he came or why he lived. He feared the dark, no doubt, and thunderstorms and big animals and queer things and whatever he dreamt about, and no doubt he did things to propitiate what he feared or to change his luck and please the imaginary powers in rock and beast and river. He made no clear distinction between animate and inanimate things; if a stick hurt him, he kicked it; if the river foamed and flooded, he thought it was hostile. His thought was probably very much at the level of a bright little contemporary boy of four or five. But since he had little or no speech he would do little to pass on the fancies fantasies that came to him, and develop any tradition or concerted acts about them.

In these questions of primitive thought, we must remember that the so called "lowly and savage" peoples of today probably throw very little light on the mental state of men before the days of fully developed language. Primordial man could have had little or no tradition before the development of speech. All primitive peoples of today, on the contrary, are soaked in tradition - the tradition of thousands of generations. They may have weapons like their remote ancestors and methods like them, but what were slight and shallow impressions on the minds of their predecessors are now deep and intricate grooves worn throughout the intervening centuries generation by generation. Thus the language enabled them to create myths and thus perceive meaning in their own lives.

The word "*mythos*" is related to the Greek meaning "to be spoken with the mouth". All myths are fundamentally, if not historically, true and lead to the highest of truths. The myths and their many facets have given birth to religion, mysticism, spirituality, philosophy or in short, to the different articulations of human quest for meaning. Myth is humankind's basic method of communicating our meaning of the cosmos and answering the why and how regarding birth, life, death of humans and the rhythms of nature. Mythology lives and breathes in us. In other words, we live and breathe our myths. Myth constitutes our very existence. We have been imprinted with certain fears and faiths that have dwelt in our collective unconscious for thousands of years. Mythology is the language of the universe of rituals, ceremonies and symbols. They are the enactments of our desire to have mystical experience, communion with reality. With and through myths we bathe ourselves in the Mystery.

2.3 THE MYTH: A SPIRITUAL METAPHOR

The crucial fact about mythology is that it is a spiritual metaphor. Myth is a guidepost to a higher truth or understanding, which if taken literally destroys its original function and meaning. For example, the myth of Adam and Eve, is a myth describing how humans became conscious and further, conscious of evil. The story is that Eve convinced Adam to eat the apple and we were thrown out of paradise. A literal interpretation of this myth has led generations of people to believe women to be the cause for evil in humanity and think of their suffering in childbirth as a just punishment. By analyzing this myth exegetically and interpreting it, we learn that the serpent in the story in all cultures, with the exception of the Old Testament, represents wisdom, the feminine goddess, power and rebirth because it sheds its skin. The tree is the Tree of Life and the World Tree found in almost every culture and is understood as the link between the conscious and unconscious, the under-world and upper-world. By eating the apple, Eve made the humans almost godlike. This myth might imply that the Divine is within us. This understanding of myth as elaborated by Carl Jung, Joseph Campbell or Paul Ricoeur, goes against the anti-historical or rational interpretations of myths, that was fashionable few decades ago. As opposed to this view we know today that we make myths and myths make us.

Campbell and Jung suggest that we create new myths because the creative act allows us to delve into and become aware of the unconscious which initially created symbols that have lasted a millennium and have bound us physically and psychically. As Campbell holds the mythical image "lies at the depth of the unconscious where man is no longer a distinct individual, but his mind widens out and merges into the mind of mankind, not the conscious mind, but the unconscious mind of mankind, where we are all the same."

The Purpose: Meaning-Making

Emile Durkheim, noted sociologist and mythologist, explained that myth exists as a social institution that orders rituals, economy, history and meaning structures of the society. He described it as the unconscious of the society. In other words, myth is a global way of thinking through which all social agendas emerge. Joseph Campbell said that we are all living (or enacting) a myth and that we must figure out what our myth is, so that we are not forced to live it against our will. He also warns that a society that takes its myth literally is suffocating itself. Studying mythical symbols is one form of bringing back the wonderfully divine, if not mystical, experience of realizing that all life is connected, at the very least, on an unconscious level. Joseph Campbell gives four purposes to myth: 1. To awaken wonder by putting us back in touch with the child within. 2. To fill all corners or niches of an image with the Mystery. 3. To validate social order. 4. To teach us how to conduct ourselves during the stages of our lives. We can further add: 5. Myths enable us to live the reality of contradictions meaningfully by giving us ideals to live by.

In summary, through myths we make sense of our reality. It provides us with meanings, enables us to organize even the contradictory experiences of our lives. It makes our lives bearable. It explains to ourselves our own experiences. It justifies our actions to ourselves and explains our failures and tragedies. Thus it has basically mediating and a motivating functions. Myths also mediate the infinite through the finite. It situates us in the vast cosmic and divine background, wherein we can find the significance of our own selves. The puny, little human actions are magnified and enriched because of the cosmic and divine significance attached to it. They also motivate our actions. They enable us to live a meaningful life within a wider horizon of significance. It is in such a horizon that we are encouraged to act. Every action, originating from

a mythical experience, becomes unique and infinitely more meaningful at least for the actor of the myth.

2.4 MYTH, PHILOSOPHY AND SCIENCE

The two narrations above are meant to show the similarity and difference between science and myth. True, for the contemporary persons, science provides us with the best knowledge possible. The primitive people used the best resources they had and came up with answers which did not quiet satisfy them, but still provided them with meaning in life and made them search further. In this process the primitive people gave us the myths, which are truly powerful in shaping our visions. None of us live according to the myths of these people. But we have our own myths: answers we give ourselves collectively and subconsciously when confronted with deep unresolved questions of life, death, reality and destiny.

As such modern humans do have our own shared myths, which most of the time we are not aware of. Only generations later, they will be able to look at us and point out the myths in our collective understanding. We do have our science, which explains to us many of the mysteries of old. Science provides us with the best explanation. But let us not forget that science of today may become the myth of yesterday. As such myth and science serve the same purpose of explaining the universe to ourselves, but at different levels. The methods they employ are different. The answers they come up with are also diverse. That is because they serve different domains of our enquiry. Science is primarily empirical and provides us with facts, while myths are based on the known facts and provide us with meaning. Such myths, when elaborated and rationalized become philosophy.

Thus there is a movement from myth to philosophy and to science. Myths are mostly factually not true but existentially meaningful. Philosophy tries to be factually true and existentially meaningful. Science attempts to be factually true and does not direct address the existential meaning. Myths provide us with intuitive and existential meaning. Philosophy gives us rational meaning. Science shows us empirical facts. Thus it is evident at as human beings we want to know, to transform and to determine our collective destiny. As individuals and group, we aspire to be related to our common origin and work towards our common destiny, though all the resources at our hand: science, religion and philosophy.

Check Your Progress 1

Note: Use the space provided for your answer

1. What are the four purposes of myths according to Joseph Campbell?

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2. Do the modern human beings have myths?

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2.5 THE GREEK QUEST FOR UNITY

In this section we attempt to show that basically the Greek quest for unity, emanated from their inmost longing to be part of the larger universe – both epistemologically and ontologically. So we shall trace the deepest philosophical quest for unity as the central driving force for all intellectual and even anthropological enterprises. As is generally presumed, the earliest schools of philosophy in the West can be traced to the sixth century B.C. in Greece. Prominent among them were, first of all, the Ionian School, the Pythogorean School, the Heraclitean School, and the Eleatic School. Right from the beginning they had one quest in common: the search for one singular essence that explained all reality. Will Durant points out five unifying elements in the civilization of the Greece that kept all its scattered cities somehow connected: a common language, with local dialects; a common intellectual life, in which only major figures in literature, philosophy, and science are known far beyond their political frontiers; a common passion for athletics, finding outlet in municipal and interstate games; love of beauty locally expressed in forms of art common to all the Greek communities; and a partly common religious ritual and belief.

Durant goes on to say that religion divided the cities as much as it united them. The city deity was believed to be the preserver, defender, and strength of the city. Just as the father was the priest in the family, the chief magistrate or archon was the high priest of the state religion in the Greek city. Polytheism was accompanied by anthropomorphic mythologies. Every craft, profession, and art had its divinity. Thus, polytheistic religion pervaded almost every facet of Greek life. Homer's Iliad and Odyssey expresses the view that the gods control all human events and the one on the side of the stronger god ultimately wins. In such polytheism, ethics mattered less. The gods themselves are pictured as slaves of lust and passion. There is no moral order since there is no single point of reference in the multiplicity of divinities. Each divinity is a point of reference in itself. Whoever serves that particular deity is under its patronage at the possibility of becoming an enemy of another deity. Egotism, revenge, heroism, and valor are extolled, as noted by Domenic Marbaniang.

The shift from multiple points of reference to a consistent moral law that is above even the gods and determines the state of the world seems to have first occurred in Hesiod. Writing sometime in the eighth century B.C., Hesiod dismissed the notion of fatality and of the gods as being morally inconsistent. Though the gods control nature, the moral order which is a product of Zeus' commands controls the structure of the universe and regulates its process of changes. Thus, Hesiod's writings can be called the transitional bridge between religious beliefs and philosophical thinking. It might have been this transitional venture of Hesiod that the Milesians undertook, indicating a substantial departure from the poetry (myth) of Homer and Hesiod and a movement toward a scientific temper (Marbaniang).

According to Will Durant, the predecessor to philosophy was a critical and skeptical outlook produced by motley of religions and cultures that intersected each other in the Greek metropolises. Athens was becoming a busy mart and port that attracted varieties of races and cults; thus, providing a context for comparison, analysis and thought. As Durant himself states: Traditions and dogmas rub one another down to a minimum in such centers of varied intercourse; where there are a thousand faiths we are apt to become sceptical of them all. Probably the traders were the first sceptics; they had seen too much to believe too much; and the general disposition of merchants to classify all men as either fools or knaves inclined them to question every creed.

Durant's speculative description of the Greek environment in which philosophy took birth may not be wrong. It is natural to reason that two opposing views cannot be both true at the same time. This points one to the inescapability of reason in searching for truth. The necessity of moral consistency might even be felt by the traders for whom fidelity matters much. On the other hand, people are seen as seeking to get nature back into their control from the hands of the gods by attempting to locate explanations for natural events in something other than the gods. Such a unifying singular was thought to be some kind of a primordial substance. As Durant writes, 'Men grew bold enough to attempt natural explanations of processes and events before attributed to supernatural agencies and powers; magic and ritual slowly gave way to science and control; and philosophy began.'

2.6 THE IONIAN SCHOOL

As Marbaniang outlines, European philosophy is born in the seaport town of Miletus, located across the Aegean Sea from Athens, on the western shores of Ionia in Asia Minor in around 585 B.C. This is why the first philosophers are also referred to as Milesians or Ionians. Ionia was a district of ancient Greece on the west coast of Asia Minor (present Turkey). It comprised famous and important cities like Ephesus, Clazomenae, Erythrae, Colophon, Smyrna, and Miletus. As Marbaniang notes, it is amazing to note how a religiously steeped Ioniaians, who had earlier on produced Homer the author of Iliad and Odyssey, should suddenly become very secular in its search for wisdom; thus, producing the first of philosophers in Western history. However, as seen earlier, the quest for control over nature might have been one reason behind the search for some natural explanation of the universe. As such the Ionians were searching for a singular thing that was the essence of all reality. If this essential thing were rightly understood, then all the other things would also be understood. Thus, human being would be in possession of a knowledge that would serve as an instrument to both explain and control natural processes.

The first of these Ionian philosophers is considered to be Thales (624- 546 B.C.). Thales asked the question: What is everything made of, or what stuff are things composed of? His contribution to thought was the novel notion that though all things differ from each other in several ways, there is a basic similarity between them all and that the many are related to each other by the One. For Thales, this one thing that united all diversity and that was foundational to all physical reality was water. According to him, it is from water that everything proceeds and into which everything is again resolved. Following Thales, Aristotle in his metaphysics observes that most of the first philosophers thought the principles of matter were the

principles of all things. In other words, the early metaphysicians were more concerned with the material cause of the universe than with any of the other causes.

That of which all things that are consist, the first from which they come to be, the last into which they are resolved (the substance remaining, but changing in its modifications), this they say is the element and this the principle of things, and therefore they think nothing is either generated or destroyed, since this sort of entity is always conserved, as we say Socrates neither comes to be absolutely when he comes to be beautiful or musical, nor ceases to be when he loses these characteristics, because the substratum, Socrates himself, remains. Just so they say nothing else comes to be or ceases to be; for there must be some entity – either one or more than one – from which all other things come to be, it being conserved.206

Aristotle makes it clear that most of the first philosophers thought that the material cause was the one, indestructible, eternal substratum to all things. For Thales, this one, uncreated, indestructible, eternal substance or essence of all things was water. Aristotle opined that Thales might have got this notion from seeing that the nutriment of all things is moist, and that heat itself is generated from the moist and kept alive by it; that the seeds of all things have a moist nature, and that water is the origin of the nature of moist things (Marbaniang).

Anaximenes and Diogenes saw air as prior to water and as the most primary of the simple bodies. Hippasus of Metapontium and Heraclitus of Ephesus said that fire was the primary principle. However, Empedocles attempted to combine the above three with an addition of a fourth, earth, thus attributing finality to the four elements: water, air, fire, and earth. Empedocles argued that these always remain and do not come to be, except that they come to be more or fewer, being aggregated into one and segregated out of one. Aristotle, however, questioned this restricting of ultimate reality to material causes only and disregarding the effective cause and final cause of things. He argued that if material causes, like air or water, are the final essentialities, then the world cannot come to be good or beautiful, and is thus devoid of any goal or purpose for existence. In his words:

…it is not likely either that fire or earth or any such element should be the reason why things manifest goodness and beauty both in their being and in their coming to be, or that those thinkers should have supposed it was; nor again could it be right to entrust so great a matter to spontaneity and chance. When one man said, then, that reason was present – as in animals, so throughout nature – as the cause of order and of all arrangement, he seemed like a sober man in contrast with the random talk of his predecessors.209

The Ionian philosophers did not seem to consider the problem of the how or why of the universe. In terms of Aristotelian thinking, such metaphysics falls short of authoritative science because “the science which knows to what end each thing must be done is the most authoritative of the sciences…and this end is the good of that thing, and in general the supreme good in the whole of nature.”210 Thus, according to Aristotle, it is not just the discovery of the material cause but also the discovery of the efficient and final causes that is important in this search for ultimate reality. This need to unravel the other causes manifests

itself though naively in theories that regard elements like fire "having a nature which fits it to move things" as the first principle.

The basic drive was, however, to find out that one element that united and was fundamental to all of nature. This doesn't mean that there weren't some who seemingly posited a pluralistic foundation of the universe as can be seen in the later Thracian materialistic schools of Leucippus and Democritus. But even in the atomic theory of Democritus, the atoms are all made of the same matter though they differ in shape, size, weight, sequence, and position. They are minute, invisible, indivisible, indestructible, and eternal.211 The quest for the One cannot be evaded in latter thinking. The Ionians, thus, can be considered to initiate the quest for the One in Metaphysics.

In summary, the Ionian philosophers beginning with Thales searched for the one, fundamental, element or principle that united all of nature. The philosophers disagreed among themselves as to whether this first principle was water or air or fire until Empedocles decided to regard all three together with a fourth, earth, as the four elements out of which all things come. The next question, inevitably, was "what is that element that was the quintessence of the four elements?" The search for the One, thus, was inescapable. The One out of which the many proceeded was considered to be eternal. However, the early Ionians left the question of efficient causality and purpose out of their theories. Though some would not consider this to be a major problem at all, Aristotle thought this to be a real problem. How can chance produce the effects of beauty and goodness in nature? There has to be an efficient and a final cause of the universe. The universe cannot be a free lunch. This led Anaxagoras212 to conclude that the cosmos is the result of an eternal governing principle called nous (intelligence, reason) that brings order out of the chaotic sea of atoms in the universe. This, however, leads to two different eternal causes: the material cause being the atoms and the efficient cause being reason. Thus, the quest for the unity in diversity of matter led to the quest for the efficient cause of all things in general.

The Ionian speculation of an eternal first material principle alludes to the following consequences, as summarised by Marbaniang:

1. Something cannot come out of nothing. Therefore, something must have eternally existed.
2. Something cannot produce its unlike; therefore, all things are made up of that something.
3. Thales (according to Aristotle's guess): All things grow in moist; therefore, water is the source of all things.
4. Anaximenes and Diogenes: Air is prior to water; therefore, air is the most primary of the simple bodies.
5. Anaxagoras: Matter is composed of infinite minute atoms which are chaotic in nature. Order out of chaos can only be created by mind. Therefore, nous (an eternal intelligence) is the author of unity and order in the universe. Since something cannot come out of nothing the material cause "atoms" are eternal. Since chaos is natural, reason must be the eternal author of order in the universe.

Consequently, the universe itself is materialistically eternal in Ionian philosophy. However, none of the Ionian philosophers were able to sufficiently explain how the primordial elements that they proposed were the basic foundation of the universe.

Check Your Progress 1I

Note: Use the space provided for your answer

1. According to Will Durant what was the predecessor to philosophy in Greece?

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2. The Ionian speculation of an eternal first material principle alludes many consequences. Name some of them.

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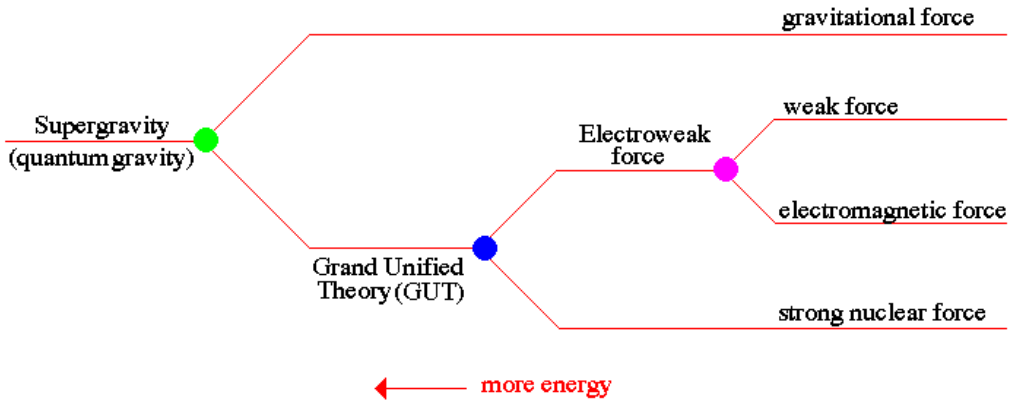
2.7 TOWARDS A GRAND UNIFICATION THEORY OR THEORY OF EVERYTHING

From the Ionians of ancient Greek we are making a tremendous leap to the contemporary scientists. We try to show that similar passion has been guiding the contemporary scientist to search for an ultimate theory that unifies everything. Contemporary physics of the early Universe is at the boundary of astronomy and philosophy since we do not currently have a complete theory that unifies all the fundamental forces of Nature at the moment of Big Bang. In addition, there is no possibility of linking observation or experimentation of early Universe physics to our theories (i.e. it is not possible to `build' another Universe). Our theories are rejected or accepted based on simplicity and aesthetic grounds, plus their power of prediction, rather than an appeal to empirical results. Our physics today can explain most of the evolution of the Universe after the Planck time (approximately 10-43 seconds after the Big Bang). One of the reasons our physics is incomplete during the Planck era is its lack of understanding of the unification of the forces of Nature during this time. At high energies and temperatures, the forces of Nature become symmetric. This means the forces resemble each other and become similar in strength, i.e. they unify. When the forces break from unification (as the Universe expands and cools) interesting things happen and we have the present universe..

Unification

all the forces of Nature should be capable of being described by a single theory. But only at high energies should the behavior of the forces combine, this is called unification



before the unification point, the forces are indistinguishable and have symmetry. After the unification point, the forces act differently and the symmetry is broken.

2.8 EINSTEIN'S PERENNIAL QUEST FOR UNITY

Buried in Albert Einstein's mail one spring day in 1953 lay a letter from an ordinary student, a 20-year-old high school dropout named John Moffat. Two totally different persons! Moffat was an impoverished artist and self-taught physicist. Einstein was a mythic figure - the world's most famous scientist. In his later years, Einstein had become increasingly isolated from the physics community, refusing to embrace the strange but powerful theory of quantum mechanics—with its particles that are also waves and that exist in no specific place until they're observed. Nature, he argued, couldn't be so perverse. So for nearly 30 years he had pursued a quixotic goal: the creation of a unified field theory to describe all the forces of nature (Tim Folger). That was the occasion for Moffat's letter. He thought he could offer Einstein some constructive criticism. "I wrote him to say that I wasn't happy about what he was doing," Moffat recalls. And he was privileged to get a reply. "Dear Mr. Moffat, Our situation is the following. We are standing in front of a closed box which we cannot open, and we try hard to discover about what is and is not in it." That closed box is the universe, and Einstein has been trying his best to open it. But, according to many of his colleagues he had contributed almost nothing of importance to physics for almost 20 years, chasing a unified theory. Did he squander his genius by chasing vainly after an ultimate theory? Though that is the generally accepted view, at least a few physicists now argue that Einstein was far ahead of his time, raising questions that will challenge researchers for decades. Moffat, who later went on to become a theoretical physicist.: "This, of course, is erroneous. Einstein never wasted his time." (Tim Folger)

Einstein's split with mainstream physics came at the very height of his career. In 1927, when he was 48, the world's leading physicists gathered at a conference in Brussels to debate an issue that remains contentious to this day: What does quantum mechanics have to say about reality? Einstein had won the Nobel Prize in physics for research that showed that light consists of particles of energy—research that laid the groundwork for quantum mechanics. Yet he dismissed the new theory out of hand. At the conference, he clashed with the great Danish physicist Niels Bohr, starting a quarrel that would last until Einstein's death in 1955.

Einstein's work was not without promise, at first. He was attempting to unite the force of gravity with the force of electromagnetism, and the two forces are similar in many ways. Einstein spent the last two decades of his life refining this idea. At the same time, he tried to iron out what he saw as problems in his general theory of relativity. In cases where gravity was extremely strong, his theories broke down. Moreover, they seemed to permit the formation of what we now call black holes — objects of such enormous density that their gravity traps even light. "Einstein didn't like black holes," Moffat says. "The real motivation for generalizing his gravity theory was to see if he could find, as he called them, 'everywhere regular solutions' that fit the equations." Such solutions, Einstein hoped, would eliminate black holes entirely. So , as Moffart says, "Einstein went into denial, because he had invested so much time in this—years!" Near the end of his life, Einstein realized that he wouldn't live to complete his work. "I have locked myself into quite hopeless scientific problems," he wrote, "the more so since, as an elderly man, I have remained estranged from the society here."

In the 1930s, when Einstein began his work on a unified field theory, physicists believed that there were only two universal forces that the theory would have to unite: gravity and electromagnetism. They have since learned that there are two other fundamental forces as well, a strong force that binds together atomic nuclei and a weak force that governs radioactive decay.

"Einstein defined what later became a fundamental problem in physics," says Carlo Rovelli, a theoretical physicist in France, as quoted by Tim Folger. After about fifty years, Einstein's once-lonely quest engages thousands of physicists around the world, most of them working on an ambitious physics framework known as string theory. Although this work is grounded in string theory and it relies heavily on some of the same components that Einstein used. But the researchers are still cautious. Moffat says that it is "pure hubris," to claim there is an ultimate theory of everything. "There's always something new on the horizon, and then everything starts all over again."

The general theory of relativity was developed in defiance of centuries of physics. It consumed Einstein for 11 years—from 1905 to 1916—and in the end was proved triumphantly correct. It's no wonder the memory of that achievement sustained him in later years. In 1953, when the letter from John Moffat found its way to Princeton, Einstein was still doing what he had always done—asking big questions and looking for big answers: looking for simplicity and searching for one unifying principle that grounds everything.

2.9 CONCLUSION: PHILOSOPHICAL QUEST

Philosophy comes from the Greek for "love of wisdom," giving us two important starting points: love (or passion) and wisdom (knowledge, understanding). Philosophy is to be pursued without passion and commitment, since it involves us totally. The primitive Neadnderthals, the Ionians, the contemporary scientists and Einstein, all of them had this goal: to make sense of our lives and of the world around us. This perennial goal could be attempted through different ways – philosophies, myths, religions and sciences. Because we are human, we just cannot cease to explore and question. Thus the passionate search of human beings everywhere to make sense of themselves in the world leads us directly to philosophy and religion and indirectly to sciences. Thus the original unity calls us back to discover our own identity and sense of belonging in this universe. In this process we grow, evolve and discover meaning.

2.10 LET US SUM UP

We have seem how humans try to make sense of the world by trying to return to an original unity, which always remains an ideal. The search for to rediscover that original unity keeps us move forward as human beings.

Check Your Progress III

Note: Use the space provided for your answer

1. What is GUT?

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2. According to many scientists Einstein had contributed almost nothing of importance to physics for almost 20 years. Is it true?

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2.11 KEY WORDS

Myths: Philosophically myths are stories, through which we make sense of our reality. It provides us with meanings, enables us to organize even the contradictory experiences of our lives. It makes our lives bearable.

GUT: The term Grand Unified Theory or GUT, refers to any of several similar models in today's particle physics in which at high energy scales where all the forces are merged into one single interaction. At this level, all the forces become one and so we have a grand unification of everything.

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UNIT 3 EVOLUTION OF THE DISTINCT METHODS OF SCIENCE

Contents

3.0 OBJECTIVES

The main object of this Unit is to give a pre-taste of different methods of science. In this unit we shall try to give a definition of scientific method, both etymological and real; then let us proceed to know how different scientific methods developed in the history of science. Further let us discuss about the scientific method and its components, the scope and importance of scientific methods in our life and how to use the different methods of science in our day to day life. At the end we come to know that a scientific method consists of the collection of data through observation and experimentation, and the formulation and testing of hypotheses and it enhances the life of humanity in different. Thus by the end of this Unit you should be able: to have a basic understanding of methods of science; to know the development of the scientific methods; to understand the all-comprehensive character of scientific methods; to know the importance of scientific methods both at the theoretical and practical levels. to know how to apply scientific methods in experiments.

3.1 INTRODUCTION

The term “science” is used to identify the various sciences, or domains of activity. First to be recognized were the natural sciences, such as physics, astronomy, chemistry, geology, and biology. The human and social sciences have also been termed sciences. Some of these are psychology, economics, education, geography, and sociology. Science has contributed much to the development of human being. By using scientific principles, man has pulled back the curtain of ignorance and advanced the quality of life. The essence of science is the scientific method where a hypothesis is tested by experiment. Instead of endless philosophical discussions to prove a point, experiment becomes the final arbitrator of truth and a successful approach. To make an experiment we need to have distinct methods to prove a point or truth. The so called "method" is so engrained in our way of approaching science today that we tend to take it for granted. The scientific method is the process by which scientists, collectively and over time, endeavour to construct an accurate representation of the world. Let us venture into the exploration of different scientific methods in this unit.

3.2 DEFINITION OF SCIENTIFIC METHOD

The scientific method or process is fundamental to the scientific investigation and acquisition of new knowledge based upon physical evidence. Science manages new assertions about our world with theories, hypotheses and observations. Predictions from these theories are tested by experiment. If a prediction turns out correct, the theory survives, but if a prediction fails the theory fails. The scientific method is essentially an extremely cautious means of building a supportable, evidenced understanding of our world. A scientific method consists of the collection of data through observation and experimentation, and the formulation and testing of hypotheses. Scientific method refers to a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. To be termed scientific, a method of inquiry must be based on gathering observable, empirical and measurable evidence subject to specific principles of reasoning. The scientific method is the basic method, guide, and system by which we originate, refine, extend, and apply knowledge in all fields.

The word science has its origins in the Latin verb *scire*, meaning "to know." Although, one can "know" through tenacity, authority, faith, intuition, or science, the method of science or the scientific method is distinct in its notion of intersubjective certification. In other words, it should be possible for other investigators to ascertain the truth content of scientific explanations. "Scientific knowledge thus rests on the bedrock of empirical testability". Empirical replication depends on a comparison of "objective" observations of different researchers studying the phenomenon.

- The Scientific Method has Four Steps
- Observation and description of a phenomenon or group of phenomena.
- Formulation of a hypothesis to explain the phenomena.
- Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations.
- Performance of experimental tests of the predictions by several independent experimenters and properly performed experiments.

3.3 THE EVOLUTION OF SCIENTIFIC METHODS

Modern western science had its beginnings with the Greeks, who conceived the revolutionary idea that the universe was a kind of machine governed by inflexible laws. This idea became the mechanistic model of science. The Greek philosophers devoted themselves to the task of discovering, through intellectual reasoning alone, the laws of the universe. Therefore Modern scientific thought, therefore, evolved from the Greek philosophers who were influenced by the Egyptians, Babylonians, and Assyrians. Their greatest successes were in the field of geometry. The Greek successes are attributable to two techniques: abstraction and generalization. So successful were these techniques in developing mathematical theory that the concepts were extended to other disciplines, but with much less success. However, the process of looking for absolute truth through reasoning alone was so ingrained in the Greek thinking patterns that they ignored the experiential evidence which was contrary to their elegant theorems and proofs.

The Renaissance thinkers, however, brought a fresh outlook. The most famous turning point came in 1543 when the Polish astronomer Copernicus published a book which proposed the sun, not the earth, as the centre of the universe. Although his hypothesis had been put forth in 200 B.C., it was in 1543 diametrically opposed to the assumptions of the Greeks and the teachings of the Church. He caused a great uproar within the intellectual world. It was left to Galileo to have the audacity to test the Greek theories. His most famous experiment probably never happened, but it makes a good story. Galileo supposedly dropped two cannon balls of different weights from the leaning tower of Pisa to prove Aristotle's theory that the heavier body would hit the ground first. The resounding thump of the two spheres hitting the ground simultaneously killed Aristotelian physics and elevated inductive reasoning as a scientific tool. Inductive reasoning begins with observations and derives generalizations (axioms) from the observations; whereas deductive reasoning, the method of the Greeks, begins with generalizations and proceeds to predict observations. But it was the recognition during the Renaissance that no amount of deductive reasoning can render a generalization completely and absolutely valid that turned the Greek philosophy upside down.

Francis Bacon offered four steps for scientific work: observe, measure, explain, and verify. And then there was René Descartes who also gave four rules for his method to find the truth in 1961. The rules are as follows:

- Never to accept anything for true which I do not clearly know to be such.
- Divide each of the difficulties under examination into as many parts as possible.
- Begin with the simplest and easiest and then work step by step to the more complex.
- Make enumerations so complete and reviews so general that I might be assured that nothing is omitted.

The essentially contemporaneous writings of Galileo, Bacon, and Descartes revolutionized scientific procedures and gave rise to what has been called the scientific method. The collective ideas which Galileo, Bacon, and Descartes brought to scientific endeavour have changed somewhat since the 17th century. By the 19th century, the method developed into six steps, and in the 20th century the method developed into seven, namely:

- Pose a question about nature, not necessarily as the result of an observation.
- Collect the pertinent, observable evidence.
- Formulate an explanatory hypothesis, defining relevant assumptions.
- Deduce its implications.
- Test all of the implications experimentally.
- Accept, reject, or modify the hypothesis based upon the experimental results.
- Define its range of applicability.

The scientific method's essential elements are iterations, recursions interleavings, and orderings of the following four steps:

- Characterization
- Hypothesis (a theoretical, hypothetical explanation)
- Prediction (logical deduction from the hypothesis)
- Experiment (test of all of the above)

Iteration is the repetition of a process, it is a repetition in a specific form of repetition with a mutable state and recursion is a particular way of specifying or constructing a class of objects with the help of a reference to other objects of the class: a recursive definition defines objects in terms of the already defined objects of the class. Interleaving is a way to arrange data in a non-contiguous way to increase performance. Orderings formalizes the intuitive concept of an ordering, sequencing, or arrangement of the elements of a set.

Characterization

The scientific method depends upon a careful characterization of the subject of the investigation. Here the subject may also be called the problem or the unknown. Observation demands careful measurement and the use of operational definitions of relevant concepts. Formally, these terms have exact meanings which do not necessarily correspond with their natural language usage. For example, mass and weight are quite distinct concepts. New theories may also arise upon realizing that certain terms had not previously been clearly defined. For example, Albert Einstein's first paper on relativity begins by defining simultaneity and the means for determining length. These ideas were skipped over by Newton with, "I do not define time, space, place and motion, as being well known to all." Einstein's paper then demonstrates that these widely accepted ideas were invalid.

3.4 HYPOTHESIS

A hypothesis is a suggested explanation of a phenomenon, or alternately a reasoned proposal suggesting a possible correlation between or among a set of phenomena. A hypothesis includes a suggested explanation of the subject. It will generally provide a causal explanation or propose some correlation. Observations have the general form of existential statements, stating that some particular instance of the phenomenon being studied has some characteristic. Causal explanations have the general form of universal statements, stating that every instance of the phenomenon has a particular characteristic. It is not deductively valid to infer a universal statement from any series of particular observations. This is the problem of induction. Scientists use whatever they can, their own creativity, ideas from other fields, induction, systematic guessing, etc to imagine possible explanations for a phenomenon under study. There are no definitive guidelines for the production of new hypotheses. The history of science is filled with stories of scientists claiming a "flash of inspiration", or a hunch, which then motivated them to look for evidence to support or refute their idea. Michael Polanyi made such creativity the centerpiece of his discussion of methodology.

Prediction from the Hypothesis

A useful hypothesis will enable predictions, by deductive reasoning that can be experimentally assessed. If results contradict the predictions, then the hypothesis under test is incorrect or incomplete and requires either revision or abandonment. If results confirm the predictions, then the hypothesis might be correct but is still subject to further testing. Einstein's theory of General Relativity makes several specific predictions about the observable structure of space-time, such as a prediction that light bends in a gravitational field and that the amount of bending depends in a precise way on the strength of that gravitational field. Observations made during a 1919 solar eclipse supported General Relativity rather than Newtonian gravitation.

Predictions refer to experiment designs with a currently unknown outcome; the classic example was Edmund Halley's prediction of the year of return of Halley's comet which returned after his death. A prediction differs from a consequence, which does not necessarily bear a time-dependent connotation. Thus, one consequence of General Relativity, which Einstein deduced, was the size of the precession of the perihelion of the orbit of the planet Mercury. The observed value, on the order of 42 arc-seconds per century, was one of the pieces of evidence for Einstein's characterization of his theory of General Relativity. This consequence was known to Einstein, in contrast to his predictions, in which he had enough confidence to publish.

Experiment

Once a prediction is made, an experiment is designed to test it. The experiment may seek either confirmation or falsification of the hypothesis. Yet an experiment is not an absolute requirement. In observation based fields of science actual experiments must be designed differently than for the classical laboratory based sciences. Scientists assume an attitude of openness and accountability on the part of those conducting an experiment. Detailed recordkeeping is essential, to aid in recording and reporting on the experimental results, and providing evidence of the effectiveness and integrity of the procedure. They will also assist in reproducing the experimental results. Integrity may be augmented by the introduction of a control. Two virtually identical experiments are run, in only one of which the factor being tested is varied. This serves to further isolate any causal phenomena. For example in testing a drug it is important to carefully test that the supposed effect of the drug is produced only by the drug itself. Doctors may do this with a double-blind study: two virtually identical groups of patients are compared, one of which receives the drug and one of which receives a placebo. Neither the patients nor the doctor know who is getting the real drug, isolating its effects.

Once an experiment is complete, a researcher determines whether the results or data gathered are what was predicted. If the experimental conclusions fail to match the predictions/hypothesis, then one returns to the failed hypothesis and re-iterates the process. If the experiments appear "successful" i.e. fits the hypothesis and then its details become published so that others may reproduce the same experimental results.

3.5 THEORY-DEPENDENCE OF OBSERVATION

The scientific method depends on observation, in defining the subject under investigation and in performing experiments. Observation involves perception, and so is a cognitive process. That is, one does not make an observation passively, but is actively involved in distinguishing the thing being observed from surrounding sensory data. Therefore, observations depend on some underlying understanding of the way in which the world functions, and that understanding may influence what is perceived, noticed, or deemed worthy of consideration. Empirical observation is supposedly used to determine the acceptability of some hypothesis within a theory. When someone claims to have made an observation, it is reasonable to ask them to justify their claim. Such a justification must itself make reference to the theory - operational definitions and hypotheses - in which the observation is embedded. That is, the observation is a component of the theory that also contains the hypothesis it either verifies or falsifies. But this means that the observation cannot serve as a neutral arbiter between competing hypotheses. Observation could only do this "neutrally" if it were independent of the theory.

Thomas Kuhn denied that it is ever possible to isolate the theory being tested from the influence of the theory in which the observations are grounded. He argued that observations always rely on a specific paradigm, and that it is not possible to evaluate competing paradigms independently. By "paradigm" he meant, essentially, a logically consistent "portrait" of the world, one that involves no logical contradictions. More than one such logically consistent construct can each paint a usable likeness of the world, but it is pointless to pit them against each other, theory against theory. Neither is a standard by which the other can be judged. Instead, the question is which "portrait" is judged by some set of people to promise the most in terms of “puzzle solving”. For Kuhn, the choice of paradigm was sustained by, but not ultimately determined by, logical processes. The individual's choice between paradigms involves setting two or more “portraits" against the world and deciding which likeness is most promising. In the case of a general acceptance of one paradigm or another, Kuhn believed that it represented the consensus of the community of scientists. Acceptance or rejection of some paradigm is, he argued, more a social than a logical process. That observation is embedded in theory does not mean that observations are irrelevant to science. Scientific understanding derives from observation, but the acceptance of scientific statements is dependent on the related theoretical background or paradigm as well as on observation. Coherentism and skepticism offer alternatives to foundationalism for dealing with the difficulty of grounding scientific theories in something more than observations.

Demarcation

Scientific Method is touted as one way of determining which disciplines are scientific and which are not. Those which follow the scientific method might be considered sciences; those that do not are not. That is, method might be used as the criterion of demarcation between science and non-science. If it is not possible to articulate a definitive method, then it may also not be possible to articulate a definitive distinction between science and non-science, between science and pseudo-science, and between scientists and non-scientists. Feyerabend denies there is a scientific method, and in his book Against Method argues that scientific progress is not the result of the application of any particular method. In essence, he says that anything goes. Thus the demarcation helps us to know the divergence of scientific methods and non- scientific methods.

3.6 SCOPE OF SCIENCE AND SCIENTIFIC METHODS

The scopes of scientific methods are massive and very useful in our life. Scientific method is not a recipe. It requires intelligence, imagination, and creativity. It is also an ongoing cycle, constantly developing more useful, accurate and comprehensive models and methods. Science is not merely a collection of facts, concepts, and useful ideas about nature, or even the systematic investigation of nature, although both are common definitions of science. Science is a method of investigating nature, a way of knowing about nature that discovers reliable knowledge about it. In other words, science is a method of discovering reliable knowledge about nature. There are other methods of discovering and learning knowledge about nature .These other knowledge methods or systems will be discussed below in contradistinction to science, but science is the only method that results in the acquisition of reliable knowledge.

Reliable knowledge is knowledge that has a high probablility of being true because its veracity has been justified by a reliable method. Reliable knowledge is sometimes called justified true belief, to distinguish reliable knowledge from belief that is false and unjustified or even true but

unjustified. The important distinction that should be made is whether one's knowledge or beliefs are true and, if true, are justifiably true. Every person has knowledge or beliefs, but not all of each person's knowledge is reliably true and justified. In fact, most individuals believe in things that are untrue or unjustified or both: most people possess a lot of unreliable knowledge and, what's worse, they act on that knowledge. Other ways of knowing, and there are many in addition to science, are not reliable because their discovered knowledge is not justified. Science is a method that allows a person to possess, with the highest degree of certainty possible, reliable knowledge, justified true belief about nature. The method used to justify scientific knowledge, and thus make it reliable, is called the scientific method. The scientific method has proven to be the most reliable and successful method of thinking in human history, and it is quite possible to use scientific thinking in other human endeavours.

Importance of Scientific method

It is of great national importance that the scientific method, which is not just for scientists but is really a general problem solving method for everyone. Centuries of study, debate, and experimentation has established that the best of all methods of obtaining and originating reliable knowledge in all fields is the scientific method. The scientific method is the guide to the mental activities and systems needed to solve the complex competitiveness problems. It is, rather, an attitude, a philosophy, an ethic to guide the process humans use to make sense out of the deluge of sensory experience which is the foundation of our progression to Paradise. As it has evolved, the method is so pervasive that it can be used in any discipline, forcing the theoretician and experimentalist to complement one another. It bridges the gap between ideas and facts, between speculation and experience, between chaos and order. It allows the sorting of the relevant and useful from the impertinent and delusive. It allows the exploitation of those rare moments of intuitive inspiration and insight which have proven so indispensable to scientific progress. However, the method cannot replace intuition, conjure good luck, dissuade misuse, or speed the slow process of intellectual growth and seasoning.

3.7 PREVALENT MISTAKES IN APPLYING THE SCIENTIFIC METHOD

In applying scientific methods we inclined to make some mistakes. The scientific method attempts to minimize the influence of the scientist's bias on the outcome of an experiment. That is, when testing a hypothesis or a theory, the scientist may have a preference for one outcome or another, and it is important that this preference not bias the results or their interpretation. The most fundamental error is to mistake the hypothesis for an explanation of a phenomenon, without performing experimental tests. Sometimes "common sense" and "logic" tempt us into believing that no test is needed. There are numerous examples of this, dating from the Greek philosophers to the present day. To ignore or rule out data which do not support the hypothesis is another common mistake. Ideally, the experimenter is open to the possibility that the hypothesis is correct or incorrect. Sometimes, however, a scientist may have a strong belief that the hypothesis is true or false, or feels internal or external pressure to get a specific result. In that case, there may be a psychological tendency to find "something wrong", such as systematic effects, with data which do not support the scientist's expectations, while data which do agree with those expectations may not be checked as carefully. The lesson is that all data must be handled in the same way.

One more common mistake arises from the failure to estimate quantitatively systematic errors. There are many examples of discoveries which were missed by experimenters whose data contained a new phenomenon, but who explained it away as a systematic background. Conversely, there are many examples of alleged "new discoveries" which later proved to be due to systematic errors not accounted for by the "discoverers." In a field where there is active experimentation and open communication among members of the scientific community, the biases of individuals or groups may cancel out, because experimental tests are repeated by different scientists who may have different biases. In addition, different types of experimental setups have different sources of systematic errors. Over a period spanning a variety of experimental tests, a consensus develops in the community as to which experimental results have stood the test of time. The scientific method attempts to minimize the influence of bias or prejudice in the experimenter when testing a hypothesis or a theory. Let us realize this and try to learn the correct way of applying scientific methods.

3.8 LET US SUM UP

We have learnt about the what, why and how of different scientific methods and the evolution of different scientific methods also have shed light upon how to use them in our experiments, decision making and problem solving in our day to day life. The scientific method is intricately associated with science, the process of human inquiry that pervades the modern era on many levels. While the method appears simple and logical in description, there is perhaps no more complex question than that of knowing how we come to know things. The scientific method distinguishes science from other forms of explanation because of its requirement of systematic experimentation. We have also tried to point out some of the criteria and practices developed by scientists to reduce the influence of individual or social bias on scientific findings. Further investigations of the scientific method and other aspects of scientific practice may be found in the references listed below.

3.9 KEY WORDS

Hypothesis is a suggested explanation of a phenomenon, or alternately a reasoned proposal suggesting a possible correlation between or among a set of phenomena.

Iteration is the repetition of a process. It is a repetition in a specific form of repetition with a mutable state.

Recursion is a particular way of specifying or constructing a class of objects with the help of a reference to other objects of the class: a recursive definition defines objects in terms of the already defined objects of the class.

Interleaving is a way to arrange data in a non-contiguous way to increase performance. Orderings formalizes the intuitive concept of an ordering, sequencing, or arrangement of the elements of a set.

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UNIT 4 RELATION OF SCIENTIFIC AND PHILOSOPHICAL METHODS

Contents

4.0 OBJECTIVES

The main objective of this unit is to analyse the relation of scientific and philosophical methods. In this process we shall try to give a detailed account and definition of philosophical methods and scientific methods. Thus after knowing the two different methods we shall examine the relation of scientific and philosophical methods. In this section let us also know about the relation of science and philosophy. Finally clarifying the importance of scientific and philosophical methods is yet another objective of this unit of study.

Thus by the end of this Unit you should be able:

- to have a basic understanding of scientific and philosophical methods;
- to know the relation of scientific and philosophical methods;
- to relate it with day – to – day life;
- to understand the all-comprehensive character of scientific and philosophical methods;
- to know the importance of scientific and philosophical methods both at the theoretical and practical levels.

4.1 INTRODUCTION

Science and philosophy, I would say, the two pillars of the universe that make it revolve efficiently. Philosophy is the study of and the attempt to gain knowledge and truth. It is a way of looking at things. It is a collection of ideas and assumptions that are used to interpret reality. It is "the rational investigation of the truths and principles of being, knowledge, or conduct." If we understand that the scientific method is a way of attaining truth, then it falls under the definition of philosophy. Science and philosophy are on the way to finding the truth. In this journey both of them use their own methods to know the truth. In this unit we are going to analyse what is philosophical method and scientific method and how these two methods are related to each other.

4.2 DEFINITIONS OF SCIENTIFIC AND PHILOSOPHICAL METHOD

Philosophical method is the study and description of how to do philosophy. A method of doing some activity is a systematic or patterned way of doing that activity. So a method of doing philosophy, or a philosophical method, is a systematic or patterned way of answering philosophical questions. The scientific method is used in science as a means of gaining understanding about the physical universe. Scientific method is the basic steps that scientists follow in uncovering facts and solving scientific problems. Scientific method refers to a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. The scientific method is essentially an extremely cautious means of building a supportable, evidenced understanding of our world. Now we know the definitions of scientific and philosophical methods. In the next section let us study the philosophical method.

4.3 PHILOSOPHICAL METHOD

Philosophy is the study of and the attempt to gain knowledge and truth. It is a way of looking at things. It is a collection of ideas and assumptions that are used to interpret reality. Philosophy is a quest for the best arguments. A good argument is a clear, organized, sound statement, the reasons which cure the original doubts in a problem. Philosophy is distinguished by the methods that philosophers follow in tackling philosophical questions. Philosophical method involves a commitment to reason and argument as a source of knowledge.

Methodology process: Methodology process is a systematic process of doubting or being skeptical about the truth of one's beliefs. In methodology process methodic doubt which is a systematic process of being doubting the truth of one's beliefs, arguments to support the solutions and dialectic, which is presenting the solution and arguments for criticism by other philosophers, and help them judge their own, are involved.

Doubt and the sense of wonder: Philosophy begins at wonder. Philosophy time and again begins with some simple doubts about accepted beliefs. We get the initial impulse to philosophize from the suspicion that we do not fully understand, and have not fully justified, even our most basic beliefs about the world.

Formulate questions and problems: The next step in the philosophical method is to formulate our doubts in questions to be answered or problems to be solved. Questioning is the first weapon of a philosopher with which one works. The more clearly the question or problem is stated, the easier it will be to identify critical issues, the assessment of which undergirds any genuine progress in coming to some sort of resolution. Here it is not enough to wonder at doubt but to state as clearly as possible what exactly the source of doubt is. Let us take the problem of freedom and determinism. We can say, suppose that, the universe operates according to deterministic causal laws, that is, for everything that happens, there are some laws which made it necessary that thing, and only that thing happened and as a result all events are determined. Suppose also this general principle applies to our choices. Our choices are events in, parts of, the natural world, and so we should fully expect to find a complete causal explanation of those too, explaining why we had to make those choices and no others. Hence all our choices are, on that accounting, determined or necessary. Nonetheless, most of us have a very keen sense that what we choose, we choose voluntarily; we could have chosen otherwise than we did choose. In short, it seems we have free will. But how is it possible, or is it possible, that our choices might be

causally determined and free at the same time? This is one way of stating the basic problem of free will and determinism.

In this example of freedom and determinism how can we clarify the statement of the problem? According to the statement, for everything that happens, there are some laws which made it necessary that thing, and only that thing happened. But here we ask, what exactly is the sense of the word necessary here? Or in another place, the statement reads, We have a very distinct impression that what we choose, we choose voluntarily; we could have chosen otherwise than how we did. But what is the strength of this phrase 'could have'? The idea appears to be that it is in some sense possible for us to choose otherwise; but in what sense of ‘possible’ is it possible? An enquiry into the problem of freedom and determinism, or any philosophical problem, can only benefit from getting very clear about exactly what the problem is, and what the terms used to formulate the problem signify.

Enunciate a solution: To enunciate a theory, or to give a definition or analysis, which constitutes an attempt to solve a philosophical problem is another essential part of philosophical method. In just a sentence or two a philosophical theory by itself can be stated quite briefly very often all the surrounding philosophical text is offered by way of hedging, explanation, and argument. Here as an example let us take a philosophical theory which has to answer the question what actions are right? For this the answer is given by John Stuart Mill, an English philosopher, as the creed which accepts as the foundation of morals utility, or the greatest happiness principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness. Consequently, according to Stuart Mill, the rightness or wrongness of actions depends on their consequences; if they tend to cause happiness they are morally right, and if they tend to cause unhappiness they are morally wrong. Whether we accept the answer or not is a different question but it does answer the question, what actions are right.

Justify the solution: Another important part of philosophical method is philosophical justifications, or arguments. An argument is a set of statements, one of which, the conclusion, it is said or implied, follows from the others which is called the premises. We might think of arguments as bundles of reasons which are logically interconnected statements. The reasons are the premises, the claim they support is the conclusion; together they make an argument. Normally philosophers are very good in giving arguments. They are constantly demanding and offering arguments for different claims they make. The reason for this is that it is only a good argument, a clear, organized, and sound statement of reasons to believe something that will ultimately cure us of the original doubts that motivated us to take up philosophy. Let us illustrate this point with an example of an argument. Say Susan has some doubts about religious matters, and she asks the question: Does God really exist? Susan’s answer is, we will say, yes. How might Susan argue for her answer? Here is a very common, popular argument, called the argument from design.

The universe is made up of a huge variety of things, inanimate and living, natural and artificial from the hills and the oceans, to the houses and ships on them, from the stars and planets, to the cities and highways. All of this huge variety of things is, as scientists well know, operating in a splendid order or harmony, much like a very complicated machine, only much more complicated and well-planned than anything that we humans have ever invented. Like a machine, this order or harmony could not have just sprung into existence all on its own; like a machine, it must have had a designer. Moreover, since the universe is so complicated and well-planned, this designer

must be incredibly intelligent; and since everything is so well-made for the habitation of humans, this designer must be very benevolent. And of course, as the creator and planner of the entire universe, this designer must be extremely powerful. So the universe must have had a designer which is incredibly intelligent, very benevolent, and extremely powerful; and this designer is what we call God. Therefore, God exists.

This argument is called the teleological argument which is studied the philosophy of religion. It offers a series of interconnected reasons to believe that there does exist the sort of entity that in various religions is called God. This sort of argument is just exactly what philosophers want from each other. To deserve our consideration, the argument does not have to be perfect. It might have some problems. In fact, it might be a very bad argument. But on the face of it, there should be something rather persuasive about it. That gives us something to analyse and learn.

Philosophical criticism: Philosophical criticism is common in the work of philosophers. It is this philosophical criticism that makes much philosophizing a social endeavour and so on. We offer definitions and explanations in solution to problems; we argue for those solutions; and then other people come along and, often, demolish those solutions, throw us into doubt again, and force us to come up with better solutions. This exchange and resulting revision of views is called dialectic. Dialectic is simply philosophical conversation amongst people who do not always agree with each other about everything. These are the five steps that a philosophical method involves in its journey towards finding the truth. Having studied the philosophical method let us move on to know about scientific method.

Check Your Progress I

Note: Use the space provided for your answer

1) What is your general understanding of scientific and philosophical methods?

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2) Illustrate the components of philosophical method?

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4.4 SCIENTIFIC METHOD

The scientific method is the only scientific way accepted to back up a theory or idea. This is the method on which all research projects should be based. The Scientific Method is used by researchers to support or disprove a theory. People attempt to understand something sufficiently to reproduce an event and/or accurately predict an event with the scientific method.

The Scientific Method has Four Steps

- Observation and description of a phenomenon or group of phenomena.
- Formulation of a hypothesis to explain the phenomena.
- Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations.
- Performance of experimental tests of the predictions by several independent experimenters and properly performed experiments.

Iterations, recursions, interleavings, and orderings are the scientific method's essential elements of the following four steps. Iteration is the repetition of a process. It is a repetition in a specific form of repetition with a mutable state and recursion is a particular way of specifying or constructing a class of objects with the help of a reference to other objects of the class: a recursive definition defines objects in terms of the already defined objects of the class. Interleaving is a way to arrange data in a non-contiguous way to increase performance. Orderings formalizes the intuitive concept of an ordering, sequencing, or arrangement of the elements of a set.

Characterization: The scientific method depends upon a careful characterization of the subject of the investigation. Here the subject may also be called the problem or the unknown. Observation demands careful measurement and the use of operational definitions of relevant concepts. Formally, these terms have exact meanings which do not necessarily correspond with their natural language usage. For example, mass and weight are quite distinct concepts. New theories may also arise upon realizing that certain terms had not previously been clearly defined. For example, Albert Einstein's first paper on relativity begins by defining simultaneity and the means for determining length. These ideas were skipped over by Newton with, "I do not define time, space, place and motion, as being well known to all." Einstein's paper then demonstrates that these widely accepted ideas were invalid.

Hypothesis: A hypothesis is a suggested explanation of a phenomenon, or alternately a reasoned proposal suggesting a possible correlation between or among a set of phenomena. A hypothesis includes a suggested explanation of the subject. It will generally provide a causal explanation or propose some correlation. Observations have the general form of existential statements, stating that some particular instance of the phenomenon being studied has some characteristic. Causal explanations have the general form of universal statements, stating that every instance of the phenomenon has a particular characteristic. It is not deductively valid to infer a universal statement from any series of particular observations. This is the problem of induction. Scientists use whatever they can, their own creativity, ideas from other fields, induction, systematic guessing, etc to imagine possible explanations for a phenomenon under study. There are no definitive guidelines for the production of new hypotheses. The history of science is filled with stories of scientists claiming a "flash of inspiration", or a hunch, which then motivated them to look for evidence to support or refute their idea. Michael Polanyi made such creativity the centerpiece of his discussion of methodology. The present-day system of methods in science is as diversified as science itself. We talk, for example, of experimental method, the method of processing empirical data, the method of building scientific theories and their verification, the method of expounding scientific results, i.e., the classification of methods based on the classification of stages of research activity. We have dealt with scientific and philosophical methods with this background let us move on to study the relation between scientific and philosophical methods.

Check Your Progress II

Note: Use the space provided for your answer

1) State the essential elements of the four steps of scientific method?

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2) Reflect the role of characterization and hypotheses in scientific method.

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4.5. THE RELATION

Can philosophy develop by itself, without the support of science? Can science 'work' without philosophy? Some people think that the sciences can stand apart from philosophy, that the scientist should actually avoid philosophising, the latter often being understood as groundless and generally vague theorising. If the term philosophy is given such a poor interpretation, then of course anyone would agree with the warning 'Physics, beware of metaphysics' But no such warning applies to philosophy in the higher sense of the term. The specific sciences cannot and should not break their connections with true philosophy.

We can find the direct relation of scientific and philosophical methods by analysing the steps. Scientific method starts wish observation and description where in observation plays a vital role. It is this observation paves way to the sense of wonder and doubt which is the first step in the philosophical method. The second method in the scientific method is formulation of hypothesis which includes a suggested explanation of the subject which helps one to formulate questions and problems which is the second step in the philosophical method. Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations is the third step in the scientific method. This prediction of quantitatively the results of new observations makes one to enunciate a solution in a problem which is the third step in the philosophical method. The fourth step in the scientific method is the performance of experimental tests of the predictions by several independent experimenters and properly performed experiments. This performance of repeated experimental tests in scientific method helps one to justify the solution that is enunciated in the third step of the philosophical method. Further it leads one to criticize the solution dialectically which is called philosophical criticism, the final step in the philosophical method. This evidently shows how scientific method and philosophical method helps one to arrive at a conclusion and how they complement each other in finding the truth.

In ancient times, as we have seen, nearly every notable scientist was at the same time a philosopher and every philosopher was to some extent a scientist. Which means both scientists and philosophers have used both the methods in their journey towards finding the truth. The connection between scientific methods and philosophical methods has endured for thousands of years. In present-day conditions it has not only been preserved but is also growing substantially stronger. The common ground of a substantial part of the content of science, its facts and laws has always related it to philosophy, particularly in the field of the theory of knowledge, and today this common ground links it with the problems of the moral and social aspects of scientific discoveries and technical inventions.

Philosophy deals with experience rather than speculations. It deals with the same materials as science and its methods even shade into the method of science. The same relation holds with the reference with the use of hypothesis in thinking and in scientific investigation. Philosophers at some time regarded it as their function to examine the unrecognised hypotheses or assumptions which underlie the procedure of scientific workers. A slightly different function which is regarded as a special problem of philosophy is the setting up of hypotheses. It has been pointed out that fruitful hypotheses are sometimes suggested by speculative thinkers before they have been thought of, much less tested, by scientists.

The scientific method has drawn many parallels with the philosophy of modern empiricism and its search for meaningful statements. The scientific method seems to be a constantly moving entity that has evolved from the first conscious thought to the present day. It appears to be changing all the time based not only on the views of individual scientists and philosophers, but also on the social situations and collective intelligence of the times, which interestingly has been affected by the method itself.

Philosophy cannot, for example, give physics specific methods for studying quantum mechanics. But it is concerned with the general approach to discovery of truth in physics. It deals not with the ‘tactics’ of the research process, but with the strategy in the battle for truth. Philosophical methods work in science not directly but mediated by other more specific methods. For example, the principle of historicism as a universal method evolved by philosophy has in biology taken the form of evolution theory, the methodological basis of the modern biological disciplines, and in astronomy this same principle has generated a whole set of cosmogonic hypotheses.

In science, methodology often decides the fate of a research project. Different approaches may lead to opposite conclusions being drawn from one and the same factual material. Describing the role of correct method in scientific cognition, philosophers have compared it to a torch illuminating the road for the traveller in darkness. Even a lame man who chooses the right road will arrive ahead of the aimless wanderer. It goes without saying that method in itself cannot guarantee success in research. Not only a good method but skills in applying it are required. Thus the connection between philosophical methods and scientific methods is mutual and characterised by their ever deepening interaction which is an ongoing process. Now we are clear about the relation between scientific and philosophical methods. This knowledge will help us to understand the importance of scientific and philosophical methods in the forth coming section.

4.6. THE IMPORTANCE OF PHILOSOPHICAL AND SCIENTIFIC METHODS

Philosophy plays a tremendous integrating role in scientific knowledge. The touchstone of the value of philosophy as a world-view and methodology is the degree to which it is interconnected

with life. This interconnection may be both direct and indirect, through the whole system of culture, through science, art, morality, religion, law, and politics. As a special form of social consciousness, constantly interacting with all its other forms, philosophy is their general theoretical substantiation and interpretation. In ancient times, as we have seen, nearly every notable scientist was at the same time a philosopher and every philosopher was to some extent a scientist. Which means both scientists and philosophers have used both the methods in their journey towards finding the truth. The connection between science and philosophy has endured for thousands of years. Science and philosophy have always learned from each other. Philosophy tirelessly draws from scientific discoveries fresh strength, material for broad generalisations, while to the sciences it imparts the world-view and methodological impulses of its universal principles. Many general guiding ideas that lie at the foundation of modern science were first enunciated by the perceptive force of philosophical thought.

Any scientist knows in his/her heart that his/her creative activity is closely linked with philosophy and that without serious knowledge of philosophical culture the results of that activity cannot become theoretically effective. All the outstanding theoreticians have themselves been guided by philosophical thought and tried to inspire their pupils with its beneficent influence in order to make them specialists capable of comprehensively and critically analyzing all the principles and systems known to science, discovering their internal contradictions and overcoming them by means of new concepts.

Truly scientific thought is philosophical to the core, just as truly philosophical thought is profoundly scientific, rooted in the sum-total of scientific achievements. Philosophical training gives the scientist a breadth and penetration, a wider scope in posing and resolving problems. Philosophy may be called the 'science of sciences' probably in the sense that it is, in effect, the self-awareness of the sciences and the source from which all the sciences draw their world-view and methodological principles, which in the course of centuries have been honed down into concise forms. As a whole, philosophy and the sciences are equal partners assisting creative thought in its explorations to attain generalizing truth. The philosophical approach enables us to overcome the one-sidedness in research which has a negative effect in modern highly specialised scientific work. It is philosophy that safeguards the unity and interconnection of all aspects of knowledge of the vast and diversified world whose substance is matter.

The scientific knowledge in various fields develops, the stronger is the tendency to study the logical system by which we obtain knowledge, the nature of theory and how it is constructed, to analyse the empirical and theoretical levels of cognition, the initial concepts of science and methods of arriving at the truth. In short, the sciences show an increasing desire to know themselves, the mind is becoming more and more reflective. Self-knowledge is the present-day trend. This trend towards self-knowledge, of which much is said both by scientists and philosophers, is bound to show itself and should show itself in the relationship between philosophical methods and scientific methods. At this juncture I would say philosophical methods and the scientific methods are two sides of a same coin. They both complement each other and enhance our day-to-day life situation. By this time we must have a panoramic view of philosophical methods and scientific methods and its relation and how they help us in our present life.

Check Your Progress III

Note: Use the space provided for your answer

1) What is the relation between philosophical method and scientific method?

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2) Describe the importance of philosophical and scientific methods.

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4.7 LET US SUM UP

Having a good introduction about the philosophical and scientific methods we have studied the definitions of philosophical and scientific methods and this paved the way to venture into what is philosophical method where in we studied the methodology process which is a systematic process of doubting or being skeptical about the truth of one's beliefs. This methodology process comprises of Doubt and the sense of wonder, Formulate questions and problems, Enunciate a solution, justify the solution and Philosophical criticism. After dealing with the methodology process we moved on to scientific methods where in we studied the four steps of scientific methodology and the four elements that are involved in that method. These two sections presented us what is philosophical method and scientific method. Now the work is to see the relation and that is what we have done in the next section which tells us the relation between philosophical and scientific methods and the connection between philosophical methods and scientific methods is mutual and characterised by their ever deepening interaction which is an ongoing process. This understanding moved us to investigate the importance of scientific and philosophical methods which tells us both methods are important in our everyday life and help us to have a clear self-knowledge. Thus we have finished the unit with a note that philosophical methods and the scientific methods are two sides of a same coin. They both complement each other and enhance our day-to-day life situation.

4.8 KEY WORDS

Argument: an argument is a set of statements, one of which, the conclusion, it is said or implied, follows from the others which is called the premises.

Dialectic: Dialectic is simply philosophical conversation amongst people who do not always agree with each other about everything.

Hypothesis: Hypothesis is a suggested explanation of a phenomenon, or alternately a reasoned proposal suggesting a possible correlation between or among a set of phenomena.

Theory: A theory is an explanation of a set of related observations or events based upon proven hypotheses and verified multiple times by detached groups of researchers.

4.9 FURTHER READINGS AND REFERENCES

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