

Topic 6. Scientific cognition and its methods

1. The world pictures.
2. The scientific world picture. The empirical and the theoretical levels of the scientific cognition.
3. Methods and forms of scientific cognition.

1. The cognition process can be realised in different ways. At different historical stages of society different world understanding ways arose and developed. The first “world picture” (system of notions about nature, society and human) appeared in the religious-and-mythological thinking context. The wish to understand and to explain the world was the manifestation of peculiarities of a human as the cultural being. The myths explained the surrounding world and mythology became a special way of spiritual life. Mythology had a great influence on the mankind’s self-cognition.

The religious-and-mythological world picture

Already at the earliest stage of the mankind development mythology was connected with mystic ceremonies and became a considerable part of religious beliefs. Mythology includes the sources of religion, philosophy, different kinds of arts, knowledge. Mythological thinking is expressed not only in oral or written texts but also in actions – ceremonies, rituals, songs and dances.

Investigation of wide circle of myths and of different mythological and religious systems allowed to ascertain that in different peoples’

mythology some themes, images and motives coincide. On this basis, different types of myths were revealed. Each of them answers one of the most important questions about the world structure.

In the cosmogonic myths the world (cosmos) origin is explained. There are two basic ideas: the world development idea and the idea of world creation. If the world was created by gods so how did the gods appear? The theogonic myths answer this question. The anthropogonic myths explain the human origin. According to mythology though the human was created by gods he is the earthy being. The gods made the human from clay, ground, dust (Babylon), from wood (Celts, Germans), from different parts of flesh (the Indian myth of Purushi, the Greek myth of Dionysus).

In mythological world picture all the “eternal” questions have answers: about the man, the world structure, the sense of its being, the sense of human being and others. This world picture has a number of peculiarities because it is the system of image-symbolic thinking but not the conceptual one. The image-symbolic thinking is emotional, concrete and closely connected with the art. There are no cause-and-effect relations in the mythological world picture; they are changed by models. Every phenomenon is explained by models or cases.

Mythological thinking offers multiversion explanations of the same phenomenon. The nature and the society worlds in mythological world picture are personalised, they receive human features. The gods come out as the symbols of nature phenomena, social life and human

characteristics. In mythological world picture there is no subject and object, all the relations are understood as subject-subjective. The world is united and it inheres with the man.

The world picture in mythology is universal; it was not built on the basis that originated from the abstract-and-conceptual thinking typical for the modern man. The world was interpreted through the subjective images system and became the constructed reality. Events in this reality were interpreted through the mythology image system. Only these images had the reality but not the world itself. The mythological world model is based on its special logic. Therefore the whole world classification system is often created (as the analogue of categories system) that allows to order being.

The mythology and religion correlation question has no simple solution. Traditionally mythology was however the starting-point for religion forthcoming. Many myths have entered the religious systems composition and they serve as the explanation for religious ceremonies. Mythology and religion are unified by the idea of the imaginary reality existence. The religious world model is similar to the mythological though it has a number of peculiarities which are typical for the world religions first of all.

The myth content is absolutely real; religion doubles the world supporting the faith into the existence of something supernatural. Poor development of abstract-and-conceptual thinking and the dominance of figurative perception of the world are typical for mythology; in

religions (in the major part of the world) theology is developed and church organisations are created.

The myth realises not only the world explanation function, the creation of the world picture. It affirmed the values system in the society, supported certain behaviour models, that allows us to speak about the socialisation function of religious-and-mythological thinking. There is also one more important function of religion and mythology – a psychotherapeutic one.

The myth as the first historical form of the world integral understanding was one of the most important source of philosophical knowledge. For a long time philosophy existed in the pre-philosophy form which was closely connected with mythology and religion especially the eastern philosophy (in the forms of Daoism and Buddhism).

In western philosophy the medieval period is also characterised by the integration of religious and philosophical knowledge. Religious-and-mythological thinking and its world picture didn't disappear but remained in human consciousness on level with the elements of philosophical and scientific knowledge. The evidence of this is the prevalence of myths and world religions as well as forthcoming of “neo-mythology”. The consciousness of modern man reveals itself as neo-mythological because now “new myths” (political, pseudo-scientific, myths of mass culture, etc.) become more and more widespread.

The philosophical world picture

This one is different from religious-and-mythological one on the basis of the world idea in the concepts system which resides to the abstract, conceptual-and-logical thinking. The main difference of the philosophical world picture is the attempt at rational explanation of the world. It was a special feature of ancient philosophy which is for now considered as the beginning of philosophical knowledge. It was in ancient philosophy that the ontological and gnoseological problems were separated from the figurative perception. Philosophy in its true meaning was realised just in Ancient Greece. For the East the religious-and-mythological world-outlook system and the predominance of ethical problems were typical. On the contrary, in Antiquity the proving type of thinking was developed. It was based on the cultivation of different ways and types of proof that later became the object of separate philosophical discipline – logic. Since that time all the problems have been formulated in the rational form with the substantiation and proofs. The rational tradition that originated in Antiquity has had a great civilisation meaning. It is not accidental that its forthcoming is connected with the “antique miracle” – the society where such political form as democracy arose.

There is no unified philosophical world picture. In philosophy, since the beginning of its history and to our time different “world models” have been offered. Monism and dualism, materialism and idealism, metaphysics and dialectics, Gnosticism and Agnosticism

offer absolutely different approaches to the real world understanding. Though philosophy is built on the principles of rationalism, proving and substantiation (that overcomes the myth) in general it keeps the primordial kinship with myth. In philosophy there exists an aim at the world integral understanding. Like the myth philosophy takes some truth by faith which gives the categorical features peculiar to mythology to philosophical principles. In philosophy the conscious engineering of special realities also remains; these realities cannot always be verified by reality.

2. The scientific world picture

It is the latest world picture which began to form in 16th – 17th centuries with a new sphere of activity – science.

Science is a sphere of human activity whose function is to produce and to systematize objective knowledge about the reality.

The connection between science and philosophy is complex. Striving to knowledge building in a theoretical form and to logically valid conclusions unites them.

The scientific world picture creates the integral image of the investigated object forming it with the help of fundamental scientific principles and concepts. Scientific cognition has a number of essential features. The most important peculiarity of scientific cognition is its systematic character. Scientific knowledge does not exist separately but in general, systematic form as a theory. The second peculiarity of

scientific cognition is its self-checking that is revealed in the methodology existence namely in substantiation of the cognition methods used.

The third feature is striving for formalisation. First it is expressed in the austerity of science language. The scientific knowledge is fixed in the form of concepts; the judgments and the conclusions in science are formulated as the principles and laws. Striving for exactness of scientific language results in its similarity to mathematics namely to the replacement of the verbal concepts by the mathematical symbols and formulas. Besides, the science cognition process is realised under certain organisation conditions observing fixed forms and principles. So science exists as social institute.

The scientific cognition is fulfilled on two levels: empirical and theoretical.

At **the empirical level** the collection of empirical data, the facts fixing, their primary systematisation and the creation of concepts take place.

The fact is an existing objectively event or phenomenon. A scientific fact is the fact described by the scientific language. Knowledge only about a single event or phenomenon is called a scientific fact. Gathering single facts explorers make their primary systematisation (fixing them in lists, tables, graphs, etc.) and lead them to the concept, namely group separate facts around one rule which is formed as a concept. **A scientific concept** is always a

statement about the essential features of objects.

At **the theoretical level** concepts are systematised, principles and laws are formulated, hypotheses are put forward and scientific theories are created.

There are two kinds of scientific statements forming theories: basic (starting) and terminal (final).

Basic statements which the theory is based on are called **scientific principles**.

Terminal statements which are proved by this theory are called **scientific laws**.

So the scientific principle is the mainframe beginning and the starting point of a theory or a concept. The scientific law is the reflecting with the help of scientific concepts of the essential objective world connections in science. The highest form of scientific knowledge existence is the theory. The most complete facts generalisation and the detection of the basic regularities of their existence are completed with the help of theories.

Theory is the generalised knowledge system of some separate reality part essential regularities. Theory is directed at the further transforming human activity – practice.

The scientific world picture does not remain the same. For a long time the idea of scientific knowledge increase as the linear process existed. Further investigation of science history revealed that scientific progress divides into two phases: the long period of gradual

advancement within the limits of available paradigm and the short period of the revolutionary changes and the paradigm's replacement. The brightest example of such revolution was the replacement of the Newton theory by the Einstein one.

In scientific world picture the investigation results are transformed into the world-outlooking and therefore they are included into culture.

3. Studying the world a human simultaneously produces the ways (methods) of cognition.

A method is the sum total of a human's practical and theoretical (also philosophical) ways and operations of mastering the surrounding world. In other words a method is the knowledge which has been transformed into the guide for action.

The doctrine of building and practical use of methods is called methodology. It is the principles and ways system of theoretical and practical activity organisation and building.

Not all the methods can be used in a definite activity, their classification is necessary. Relatively they can be private (particular), general and universal. Besides they may be classified depending on their cognition level. In this case there are empirical and theoretical investigation methods. There are also general methods which are used on the intermediate level (between the empirical and theoretical ones).

The empirical level methods.

Observation is the first form of a human's attitude to the world, of

their activity. It is a teleologically organised perception of the objective reality phenomena. The result of the observation is primary knowledge about the external sides, features, characteristics, connections and relations of things, phenomena and processes.

Closest to observation are comparison and description.

Comparison is revealing of similarity or differences between the objects.

Description is fixing of experience results.

The most important method on this level is the experiment.

The experiment is a method which presupposes the object's change that is creation of certain conditions. The success of an experiment depends on the subject activity. There are material experiments and mental experiments. The latter are the system of logical procedures with idealised objects.

For systematisation and treatment of knowledge received by observation and experiment transitional, intermediate level methods are used.

The intermediate level methods.

These methods are usually used in each science, in every investigation because they have a universal character. They are analysis, synthesis, deduction, induction and classification.

Analysis is the division of the whole into parts to cognise each of the parts.

Synthesis is the reverse procedure when separated elements are

united in one whole (system) for its cognition.

Analysis and synthesis are the unity of oppositions which supplement each other.

During the cognition process, knowledge is extended that allows to increase the conclusions generalisation level and to pass on from the base of facts with the help of the inductive method to more general knowledge. Also, it creates regularities formulation circumstances.

Induction is the method when making a general conclusion on the basis of less general knowledge. Induction is the movement of thought from the single to the general. The induction bases are observation, experiment, comparison, description, analysis and synthesis which give knowledge about separate objects and their features.

Deduction is the induction opposition; it has exact theoretical directness and connection with induction, similar to analysis and synthesis.

Classification assists scientific knowledge to pass from the empirical stage to the theoretical generalisation. It is the highest stage of description that is ordering of factual empirical material according to the revealed general, particular and single features.

All these methods lead to the theoretical level.

The theoretical level methods.

This level is characterised by increasing of generalisation, by reflecting of internal essential world connections and regularities, world separate elements and objects. Transition from the empirical to

the theoretical is revealed in ascension of the phenomenon to the essence, of the primary essence to the secondary one, of the abstract knowledge to its synthesis in theory.

At the theoretical level the methods of ideal object building (modelling, formalization, deduction, axiomatic method), the theory substantiation methods (historical and logical, ascension from abstract to concrete, the hypothetical-and-deduction method), etc. are used.

Idealisation is the process of mental constructing of the concepts of those objects which don't exist in objective reality (for example, the absolutely black body model in physics or the point idea in mathematics) but which have prototypes in the real world. This feature distinguishes the idealisation from fantasy. Idealised objects help to cognise real objects, to build abstract schemes of real objects and processes. In this sense idealisation is closely connected with the modelling method.

Modelling is a method of objects investigation with the help of models (copies) which are taken instead the original. Modelling is used when a real process can't be investigated, for example, thermonuclear processes on the Sun. This method is widespread in the system of education.

Modelling may be material and ideal (symbolic, informative).

Formalisation is the content revealing process by the sign formalism method, by the form generalisation. However the utmost form generalisation leads to formalism in science.

Deduction is the particular conclusions (premises) receiving method on the basis of general ones. Both scientific facts and hypothetical judgments can be used as the general premises. The deduction use is connected with certain mental rules system use. It is called logic. Mostly deduction is used in mathematics, theoretical physics and other high level theoretical generalisation sciences.

In the basis of **axiomatic method** the axiom concept lies. An axiom is the statement which doesn't need any proof. For example, the Euclid geometry was built on the premises which were true intuitively. The formalised axiomatic systems building leads to great success in sphere of mathematics.

Historical and logical methods are very important in theoretical investigation. The base of historical method is the real history and a variety of its manifestations studying. The logical method reveals real history and being development logic. These methods are used as the theoretical knowledge building ways of natural and social reality. They reflect the same processes; therefore they coincide with the content but differ by the form. The unity of historical and logical methods allows to consider the object or the process in their unity: the past, the present, the future.

The ascension from the abstract to the concrete is used both in natural sciences so in social ones. Here the concrete is considered on two levels: as sensitive data and as an element of theoretical knowledge. Each object or process realises its objective being by a

number of connections, relations, interconnections which can't be cognised by man immediately. In the cognition process something is fixed and something is deviated, abstracted. Cognising separate sides of things, connections and relations man has to bring all his knowledge into a united system that is reflected in the dialectics of the abstract and the concrete.

The hypothetical-and-deductive method means that the knowledge development is going not from the empirical (experience) to the theoretical generalisations and conclusions but vice versa: first the hypothetical construction (hypotheses system) is created and then the experience checking of judgments (hypotheses) is realised. The practice confirms and transfers them into the true scientific knowledge class or denies them as an error.

In real scientific cognition all the methods may reveal themselves simultaneously, in interconnection. Their concrete use in every separate case is defined by the level of scientific cognition and also by the peculiarities of the object and the process. The latter never remain the same.

The **forms of scientific cognition** are: the fact, the problem, the law, the hypothesis, the theory.

The fact as a scientific cognition form characterises authentic empirical knowledge that is established, proved knowledge about some manifestations, characteristics and features of objects under study. The empirical fact is formed on the interpretation basis with the

help of already existing knowledge. Then it can be used for building of new, non-existent theoretical knowledge.

So the problematic situation appears as the first phase of scientific problem. **Problem** as the scientific cognition form characterises the knowledge about recently discovered and previously unknown sides of familiar object. In other words, it is certain knowledge about the unknown, the fixing of what needs to be discovered and explained.

If this break can be liquidated soon this new knowledge can become a scientific law. **The law** is a characteristic feature of the necessary, stable, essential, repeated connections between the phenomena. The law expresses the connection between the things, between the elements composing the thing essence, between things features as well as between the characteristics of the thing. There are operation laws and development laws.

If the break in knowledge can't be liquidated by the ways possessed by the scientific community or at a separate investigator it becomes the principal one. So there appears the necessity of new knowledge development which can remove the break. For the first time this new knowledge reveals itself as a hypothesis.

The hypothesis is a scientifically grounded suggestion including new theoretical knowledge which explains new facts that were hard to take with the old theory and that caused problems. So there appears a necessity of new knowledge generation. The hypothesis can't oppose the laws existing in the same sphere but this requirement is not

absolute.

When a hypothesis transforms into a theory it doesn't change the content because the developed and grounded hypothesis is complete and comprehensive knowledge system.

The theory as a scientific cognition form has a complete structure. The basic theory structure components are theoretical models that are the abstract objects system which is the core of a theory stringing on itself all the theory statements. The theoretical model is fully connected with the mathematical apparatus of the theory.

Generally scientific cognition continues common human cognition and in modern philosophy it is one of the most popular problems.