

**ROLE OF HIGHER EDUCATION INSTITUTIONS IN SOCIETY:
CHALLENGES, TENDENCIES AND PERSPECTIVES**

Academic papers

Nr. 1 (8)

WHAT IS SCIENCE?

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Summary

The presented article is the result of research of the essence of science, history of science, principles of scientific research, and methodological approaches to its implementation. Particular attention is paid to the principles, approaches and methods of scientific research at the present stage of the development of science, because profound awareness of them makes it possible to carry out a genuine and unbiased scientific research. Special attention is paid to propaganda in science as a destructive element that obliterates the basic principles of scientific research and provides the main results of the study with subjectivity.

Keywords: science, scientific method, scientific research, independent science, principles of scientific research, propaganda.

Introduction

The purity of science and the results of scientific research essentially depend on the researcher's understanding of the essence of the science itself, because personal perception affects the approaches and methods used in the process of the study. Therefore, it is extremely important to understand the essence of the very concept of "science", and to highlight the main events each of which have become somewhat of a turning point in the concept of science and its independence.

Thus, the purpose of scientific research is to reveal the essence of the category "science", the history of its formation, as well as to highlight the peculiarities of scientific research.

To accomplish the tasks, a whole set of general scientific and special research methods was used: method of abstract logic, in particular methods of analogy and comparison, induction and deduction, scientific abstraction (for clarification of the conceptual apparatus on the problem being researched), statistical methods, namely: graphic, systemic, comparative, grouping (for clarification of methods and approaches to scientific research), etc.

The information base of the research is regulatory legal acts of Ukraine, official statistics of the State Statistics Service of Ukraine, the State Fiscal Service of Ukraine, information resources of the Internet.

The information and methodological base of the research is the scientific works of leading Ukrainian and foreign scientists, periodicals, reference books, international electronic databases, information resources of the Internet.

Some approaches to understanding the concept of "science"

"What is science and where does it come from?" is a question asked by every scientist at least once in his or her life.

It turns out that everything is very simple and yet quite difficult at the same time. The word "science" comes from the Latin word "scientia", which means "knowledge". Today, there is a large number of approaches to the definition of "science", which may be explained by the large number of researchers who studied it and the individuality of each and every one of them. For example, Harper, Douglas interpret the Latin origin of the word "science" as "a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe" (Harper). This way, scientists emphasize the need to justify all findings and results obtained through the study. The National Academy of Sciences tells us that science is "the use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process" (National Academy of Sciences? 2008). This approach to defining the concept of "science" draws the reader's attention to the fact that science is based on certain evidence, the interpretation of which allows to justify certain phenomena, to make a prediction (which should be true), as well as to accumulate certain knowledge.

The Cambridge dictionary defines the category of "science" as "the systematic study of the structure and behavior of the natural and physical world, or knowledge acquired about the world by watching it carefully and experimenting" (Cambridge dictionary).

Stephen Jay Gould notes that "the net of science covers the empirical universe: what it is made of (fact) and why does it work this way (theory)" (Daubert v. Merrell, 1993), thus emphasizing the equal importance of both empirical and the theoretical components of science.

The US Supreme Court points out that "science is not an encyclopedic body of knowledge about the

universe. Instead, it represents a process for proposing and refining theoretical explanations about the world that are subject to further testing and refinement. However, in order to qualify as 'scientific knowledge,' an inference or assertion must be derived by the scientific method. Proposed testimony must be supported by appropriate validation – i.e., 'good grounds,' based on what is known. In short, the requirement that an expert's testimony pertain to 'scientific knowledge' establishes a standard of evidentiary reliability." In our opinion, such an approach is the most complete one, since, along with the importance of using a certain set of evidence and the accuracy of their interpretation, it indicates the need to use the scientific method. We agree with this approach, because we believe that the choice of research methods and the ability to use them significantly affect the results of all scientific researches.

The main stages in the history of science

Science goes back to the earliest times with the emergence of the Homo Sapiens, because science is what is in the head of a particular person and does not require anything else as much as the ability to observe and comprehend what has been seen, heard, and existing experience. Science has been developing along with the development of mental abilities. Therefore, it is obvious that the first "scientific" attempts by Homo Sapiens were extremely difficult and important for him, yet relatively primitive for the modern man. Thus, the ability of our ancestors to develop weapons or tools, to hunt a mammoth, to tame a horse or to grow wheat can be considered as a certain scientific result.

However, within several millennia science had reached a high level. Perhaps we do not have any printed evidence of the development of the science of the Ancient World. However, all of the rock paintings, ancient papyruses, and in general the monuments of the Ancient World, known to us as the Seven Wonders of the World (among which, unfortunately, only the Pyramid of Cheops remains largely intact) could be considered as evidence.

Diogenes outlined the basic principles of actual science and they were passed on to us along with the legends about his life. Thus, according to one legend, in about 300 BC Alexander the Great came to Corinth to meet the famous philosopher. Diogenes usually lay in the middle of the marketplace in front of his large ceramic jar and relaxed in the warmth of sun. Having heard the noise, the philosopher turned his head, looked at the king who was approaching with his numerous retinue, but did not even move. Alexander greeted Diogenes and asked him if he needed anything: all his wishes would have been fulfilled immediately if it were so. "I have one wish," the wise man said, "for you step aside and stand out of my sunlight." (Mark, 2014). This brief history transmits the Diogenes vision of science well, he did not want to be dependent neither on power nor on society, therefore, and did not want to influence someone's thinking. These thoughts subsequently formed the basis for the principles of scientific research, which we will consider later.

A few centuries later, another important event happened and it became decisive in the history of science, namely the Humboldt decree, was signed in the beginning of the 19 century. Before the Humboldt Decree, the science was under the influence of the universities. It became free from the universities after the Humboldt Decree. Therefore, every person who wants to be a scientist can follow his or her ambition (everything depends on personal abilities). It is important to mention that in Ukraine you should have the official title or scientific degree to publish your findings independently. Otherwise, you have to have a supervisor or have someone else who has this title.

It is worth noting that, despite all the positive trends, science in Ukraine could hardly be called independent. For example, publishing the results of a scientific research is too subjectivated. Publications that publish such results and are respected in the scientific community are usually issued either by educational, scientific or state institutions. In addition, in order for the results to be published, they must be reviewed. Consequently, in such circumstances, there is a threat of propaganda from the above-mentioned institutions.

Scientific research

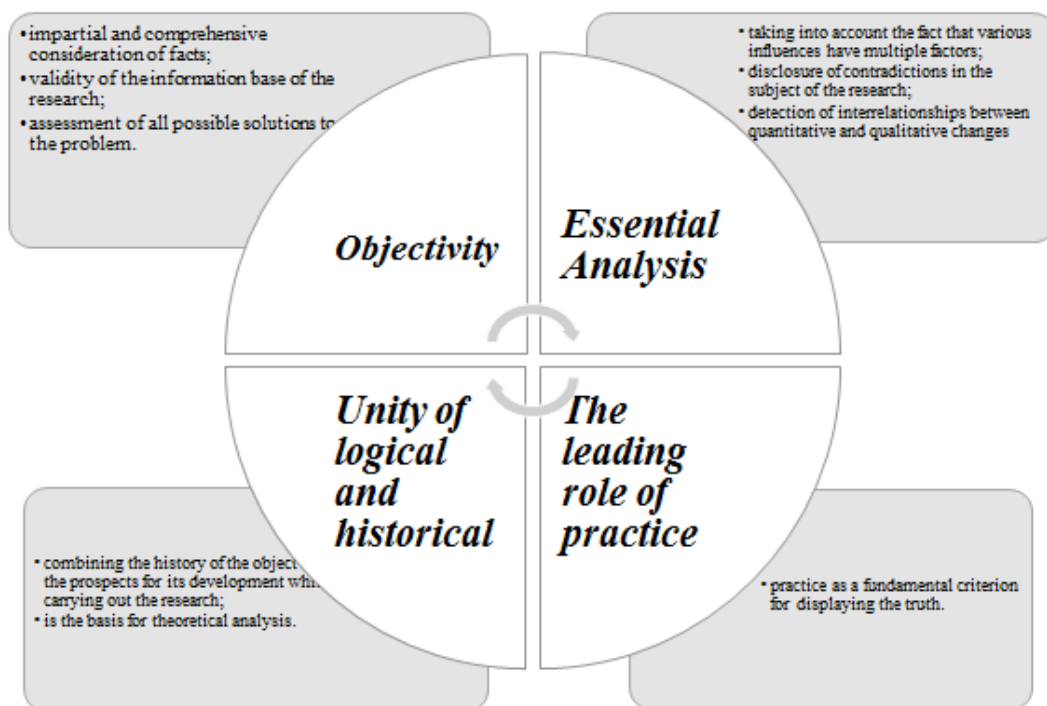
Scientific research should be based on certain principles, according to certain approaches and use different methods that make such research most effective.

One can define four basic principles of scientific research, namely:

- the principle of objectivity;
- the principle of essential analysis;
- the principle of unity of logical and historical;
- the principle of the leading role of practice.

The principles, on which scientific research must be based, and their content are presented at Picture.

1.



Picture 1. The content of the fundamental principles of scientific research *

* compiled by the author on the basis of (Walton, 197)

The principle of objectivity. Scientific research is under the significant risk of subjectivity, since the scope of research problems and issues is extremely broad and it is obvious that various scholars research and analyze them differently, based on their own experience, world perception, and also taking into account a variety of factors that influence (or can influence) the subject of research. This risk is further exacerbated in the context of globalization processes, which mean a significant convergence of practices and traditions of research in different countries.

Precisely due to the principle of the objectivity of the research, it is possible to avoid or significantly reduce the aforementioned risk. It is possible to ensure the implementation of this principle by means of a clear justification of the original data of the research, which should contain a comprehensive disclosure of the results of previous studies of the subject.

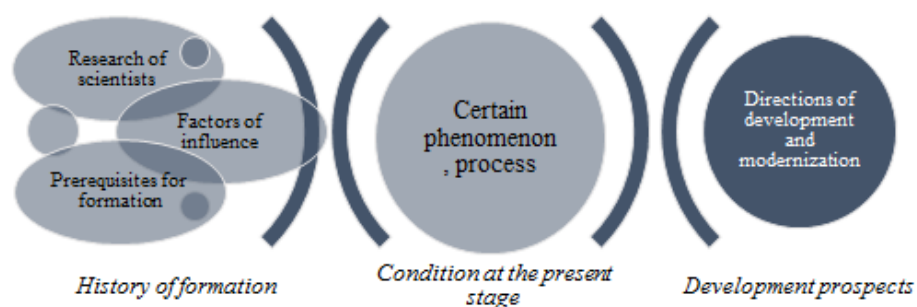
Hence, an adequate information base of research enables to take into account the complex of factors influencing the subject of research is also extremely important, since any factor may have different influence depending on different circumstances, political system, stage of economic development etc. For example, it is obvious that at a high level of ensuring social welfare by the state in Sweden, it will be much easier for society to accept the increase in income tax there than in Germany or Ukraine.

In addition, the principle of objectivity requires the logic of research activities, their consistency and making reliable conclusions on this basis; therefore, given the complexity and systematic nature of the subject of research, it is important to use the data and results of research from sources from different countries.

The principle of essential analysis. The logic of conducting research should be constructed in such a way as to preserve the movement of research from the description to the substantiation of various processes, and then to prediction and modelling the development of the phenomenon. It is therefore desirable that scientific research should contain all of the elements mentioned. The logic of research is presented at Picture 2

Picture 2. demonstrates a consistent transition from the disclosure of theoretical and methodological foundations of a particular problem to the substantiation of processes and the formation of a strategic vision of the processes. This logic of research fully ensures compliance with the principle of essential analysis.

Principle of unity of logical and historical. Scientific research anticipates a combination of both studying the history of the formation of a certain phenomenon to the present state and prospects for development. Historical analysis is carried out from the standpoint of a certain scientific concept, taking into account all elements of the investigated phenomenon or process. Graphically it can be represented as at Picture 2.



Picture 2. Scientific research according to the principle of unity of logical and historical *

* author's development

Principle of the leading role of practice. Observance of this principle requires the scientist to bring research closer to real life, since the main objective of scientific research is the positive transformation of society. Therefore, research results should be tested in practice.

Another important principle of scientific research is the principle of independence, which essentially proceeds from the principle of objectivity. This principle is of paramount importance, since it is the one that helps to avoid propaganda.

In 1966, Richard Feynman wrote, "I think we live in an unscientific age in which almost all the buffeting of communications and television – words, books, and so on – are unscientific. As a result, there is a considerable amount of intellectual tyranny in the name of science" (Feynman, 1966).

The cause of propaganda as a phenomenon is that governments own many of the sites and want the scientists to use their information. The main aim is to give for the scientists "real" and acceptable to them information.

Katherine Fitzmaurice says that historically, propaganda has always been used as an instrument of control and conformity by the dominant social power (Fitzmaurice, 2018).

There are different types of propaganda. The common known types of propaganda are:

- Black propaganda;
- Gray propaganda;
- Negative (destructive) propaganda;
- Positive (constructive) propaganda.

As we see from typology, propaganda can be constructive. Douglas Walton mentions, "The word 'propaganda' has a mixed quality. It is generally negative in its connotations, and the negative aspect seems to be at least partly logical in nature, suggesting that the discourse in question is somehow untrustworthy, deceptive, or not a kind of argumentation that is based on a balanced consideration of the evidence relevant to the issue being discussed" (Walton, 1997). However, that is not the source for real independent science. As science should be "pure" and not dependent on any external biased opinions.

Approaches

The formation of new approaches to the interpretation of processes and phenomena essentially depends on the scope of methodological approaches chosen by the researcher. Table 1 presents methodological approaches, the use of which is the most grounded from the scientific and practical point of view.

Table 1. General characteristics of methodological approaches to research phenomena and processes *

Approach	Contents
Chronological (historical)	Study of processes in chronological sequence. Allows revealing certain sequences, relationships, patterns, and contradictions.
Terminological	Research of concepts and categories in order to find out their content, clarification, definition of relationships, and the formation of the hierarchy of the conceptual apparatus.
System approach	Required for each research object. Comprehensive study of large and complex objects.
- Structural and functional	- allocation of structural elements in the objects with indication of the importance of each of them and the establishment of interrelationships between them.
- systemic and activity	- allocation of human activity as a separate component.
- systemic and genetic	- definition of the conditions of origin, development and transformation of the system.

Informational	The process of obtaining, processing, transforming, storing, and distributing information in order to deepen knowledge about the subject of research.
Formal (technical)	Establishment of certain mathematical regularities between processes and phenomena due to formalization of theoretical knowledge (with the help of mathematical signs and formulas).
Synergistic	Research of processes of self-organization and the formation of new orderly structures. Provides a probabilistic vision of the world, based on the study of nonlinear systems.
Axiological (value)	Allows you to evaluate a particular research object from the standpoint of value that it carries to a particular individual or society as a whole.

* compiled by the author on the basis of (Chmylenko and Zhuk, 2014; Vazhynsky and Shcherbak, 2016)

Application of the methodological approaches presented in Table 1 makes it possible to conduct research, so to speak, to a full extent taking into account factors of influence of external and internal environments, processes, as well as objects which the research influences. Let us examine each of the approaches in detail.

Chronological approach. The application of this approach allows to preserve the relevance of the object being studied, since the research objects that have a certain history (as such objects) tend to show a change in the perception of them by the scientists, as well as other subjects (state, businesses, population, etc.), as well as qualitative change of the subject of research, its complication, and the change of structure. Such research ensures the identification and consideration of those factors that have led to these changes and taking into account all of them and other newly discovered factors.

Terminological approach. For any research, it is important for both the research implementers and their end users / consumers of information to perceive and interpret the outlined information in the same way. In order to eliminate or minimize inaccuracies in the interpretation of the summaries, a thorough analysis of the key terms and categories used, the clarification of their content, and the determination of relations between them and their hierarchy is necessary.

System approach. The need for a system approach is stipulated by the need to expand research work from the simple definition of elements that are components of the subject of research, to determining the relationships and dependences between them. Moreover, it is important to consider that each system in its turn is a component of another system, the other elements of which also may have an impact on it.

In addition, within the framework of the systemic and activity approach, it is necessary to research the human factor. The reason is often the research system is embodied in the activities of individuals who, according to modern studies of behaviorists, not only differ in their level of professionalism, education, and competencies, but do not always act like an “economic man” (*homo economicus*), that is, rational, but rather like a “wise man” (*homo sapiens*) (Taller, 2018), which carry out their activities according to the set of emotions that control them at the time of decision-making.

The *systemic and genetic* approach will enable us to explore the factors and conditions that have led to the emergence of ideas of scientific research, contributed to their development, transformation, and now require modernization.

Informational approach. All phenomena in nature are in essence informational; therefore, their research involves work with various arrays of information. Moreover, the implementation of scientific research involves not only the work with these arrays (collecting, processing, and interpreting) but also forming new arrays of information that will have an impact on further scientific research.

Formal approach. Usually scientific research is based on complex calculations that are formalized in mathematical records. At the same time, such research involves the practical analysis of data arrays, which is carried out based on existing statistical and analytical databases, the formulation of mathematical hypotheses, resulting in a new round of formalization of the obtained results and the identification of regularities and connections.

Synergetic approach involves a probabilistic vision of the world, based on the study of nonlinear systems (Chmylenko and Zhuk, 2014).

Axiological (value) approach. Research for the sake of research has no meaning, so it is important to investigate what kind of value it can bring for the society and the state.

The use of all these approaches in the process of scientific research will enable the formation of objective, useful and most importantly applied conclusions and recommendations.

Levels and methods

Scientific research is carried out mainly on two levels: theoretical and empirical. These levels, though being essentially different, are deeply interconnected in practice, because the received facts, phenomena, and

processes were obtained at the empirical level are being explained at the theoretical level. So, let us consider both of the abovementioned levels of research.

The theoretical level of research differs from the empirical one in that at this level the researcher deals with the individual elements of the model of the object being studied, which is the result of the thinking activity of previous researchers, while at the empirical level the researcher works with real objects. Thus, there is a certain distancing from the actual reality at the theoretical level.

At the theoretical level, systems of knowledge and theories, in which the general and necessary relations are brought to light, are formulated; and the laws are formulated in their systemic unity and integrity (Klymeniuk, 2005).

At the theoretical level, the main task of research is to disclose the essential causes and connections between phenomena, and the cognitive function – to explain phenomena in the form of laws, theories, theoretical systems and system laws. At this level, rational learning and knowledge dominates.

At the theoretical level of research, it is very important to have a certain apparatus that simplifies research: conceptual, scientific and methodological, and theoretical (Donetsk national University).

Conceptual apparatus is a set of concepts, categories, terms, and definitions that are fundamental to research, provide a clear understanding of the progress of research and the results obtained for both the researcher and the end consumer of information.

Theoretical apparatus is a definite set of scientific conclusions and recommendations derived from the implementation of the theory into practice.

Scientific and methodical apparatus is a set of developed methods for solving problems (scientific and practical), the use of which leads to obtaining new scientific results, including a set of research methods. It is important to use both general scientific and special research methods that will enable us to achieve the integrity and depth of research.

In our opinion, the most suitable research methods at the theoretical level are the following:

- Abstraction. This method can be used precisely at the theoretical level of research. According to it, it is necessary to distinguish between influences and connections that are extraneous to our research.

- Idealization. Just like the previous method, it is possible to “clear” research from “unnecessary” influences. Thus, by rejecting all unnecessary factors, one can construct mathematical models that reveal certain connections and patterns. Further, other factors can be gradually introduced into the models.

- Classification makes it possible to detect homogeneous elements that are being researched.

It should be noted that these methods have one significant drawback – none of them deals with the object of our research. However, these methods make it possible to establish certain patterns, common to different elements of the features and factors of influence, etc.

Unlike the theoretical level, the empirical level is characterized by the direct observation of the phenomena and objects based on which the facts are recorded, the patterns that are inherent in the subject matter independently of geographical or historical factors are brought to light. At this level of research, the sensory component of knowledge dominates.

Methods of empirical research are measuring and testing.

Measuring. Fixing and recording (register) measurable data quantitatively correspond to the object of research and so is their mathematical interpretation.

Testing. This method is used at the empirical level of research. It involves forming a standardized set of questions that are provided to respondents in order to obtain a certain array of information, which, according to the used scale, allows us to estimate the hypothetical assumptions made at the previous stage of research.

Let us note that the methods used at the theoretical and empirical levels are strongly interrelated and have a significant level of dependence, they determine each other in the general structure of scientific knowledge. Conclusions obtained at the empirical level become the basis for theoretical research, while theoretical inferences become empirically accessible.

In order to specify the research, as well as to derive clear patterns, we use mathematical research methods in our research.

Mathematical modelling allows not only to establish links between different elements of the state's financial policy and to measure their close proximity, but also to predict the results of various options for its modernization.

Conclusion

Real science is characterized by certain peculiarities: Science comes from the abstract and independent process of thinking; Scientists do not construct something that exists; Independent science does not rely on anything or anyone; the only motivating factor for and the result of the independent science is scientific thought. The “purity” and independence depend significantly on the set of scientific methods and approaches, as well as from adherence to the principles of scientific research.

Acknowledgment

This scientific article was produced at the Fil. Dr. Jan-U. Sandal Institute, Finstadjordet, Norway under the supervision of Prof. Fil. Dr. Jan-Urban Sandal, Executive Director and Owner at the Fil. Dr. Jan-U. Sandal Institute (Excellence in Science and Education). The paper was produced with the support of Summit Fund (ES-01-A- Scientific Entrepreneur Grant) awarded by Fil. Dr. Jan-U. Sandal Institute.

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Anotacija

KAS YRA MOKSLAS?

Straipsnyje akcentuojama mokslo esmė, jo istorija, mokslinių tyrimų principai ir metodologiniai jų įgyvendinimo metodai. Ypatingas dėmesys skiriamas mokslinių tyrimų principams, metodams ir metodams dabartiniame mokslo vystymosi etape, nes gilus jų supratimas leidžia atlikti tikrą ir nešališką mokslinį tyrimą. Ypatingas dėmesys skiriamas propagandai moksle kaip destruktiviam elementui, kuris neigia pagrindinius mokslinių tyrimų principus ir pateikia pagrindinius tyrimo rezultatus subjektyviai.

Tikrasis mokslas pasižymi tam tikrais ypatumais: mokslas kilęs iš abstraktaus ir nepriklausomo mąstymo proceso; mokslininkai nesukuria to, kas egzistuoja; nepriklausomas mokslas niekuo nesiremia; vienintelis motyvuojantis ir nepriklausomo mokslo rezultatas yra mokslinė mintis. „Grynumas“ ir nepriklausomumas labai priklauso nuo mokslinių metodų ir požiūrių, taip pat nuo mokslinių tyrimų principų laikymosi.

**AUKŠTŲJŲ MOKYKLŲ VAIDMUO VISUOMENĖJE:
IŠŠŪKIAI, TENDENCIJOS IR PERSPEKTYVOS**

Mokslo darbai

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Editor – in – chief Kankevičienė Lina

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Technical editor Leščinskienė Danguolė

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Vyriausiasis redaktorius Kankevičienė Lina

Vykdantysis redaktorius Balynienė Rasa

Techninis redaktorius Leščinskienė Danguolė

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