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The importance of hierarchy and classification of sciences in the educational process

Viktor Biryukov
Department of Pediatrics of Odessa National Medical University, Odessa, Ukraine
ORCID 0009-0002-4113-0138

Abstract: The work is devoted to the current issue of a systemic nature. A positive attitude toward the need for the classification of sciences is justified. The arguments are the facts of the creative influence of the classification of sciences on: 1. Optimization of knowledge structuring. 2. A clearer identification of the specialization of sciences is needed. 3. Classification helps to see differences and connections between sciences. 4. Form the methodology of knowledge. 5. Forms the educational process. 6. Carries out synergism of scientific communications. 7. Potes the economic and managerial feasibility of structuring sciences. The work considers the task of substantiating a new modern methodology and reflecting the dynamics of the emergence of new scientific areas. Both structural-functional and hierarchical approaches are used. The subject of the study (subject) is the patterns of the emergence of new scientific areas in the modern world. The object of research is the possibility of logical and graphic interpretation of the formation of new scientific areas and their relationships. Models of a historical approach and classification of sciences in terms of fundamentalism and object of research are proposed. The trends of the 21st century, which should be taken into account by classifiers of science, are represented 1. Convergence of NBIC technologies: nano (material science), BIO (general engineering), info (quantum calculations). Cogno (neuro interfaces). 2. Revolutionary changes to the methodologists are presented: the fourth paradigm (given-oriented science): CERN: 30 petabytes/data year with a tank; Alphafold: prediction of 200 million protein structures. 3. The emergence of new disciplines: Cliodinomics: mathematical modelling of historical processes. Astrobiology: Search for life outside the Earth + synthetic biology. The forecast has been made that further studies should show that the real, relevant hierarchy of sciences should discard the image of the hierarchical staircase and take the form of a neural network with cross-bonds, where breakthroughs arise at the joints of the disciplines. With this approach, mathematics remains the “queen of sciences," but its power is now shared with science and complexity theory. A dynamic interference model is proposed to predict the development of new directions.

Keywords: classification of sciences, classification methodology, principle of hierarchy, structural and functional analysis, dynamic interference model.

1. Introduction

The classification of sciences is a necessary procedure that allows you to structure the infinitely changing sphere of scientific knowledge. The systematization of knowledge and disciplines for natural, humanitarian and technical helps a better understanding of the meaning of the diversity and relationship of science. In ancient times, a science uniting a set of knowledge was philosophy. The second half of the XX and the beginning of the current century are characterized by the rapid growth of various scientific areas, both fundamental and applied, which cannot be combined under a single flag of philosophy. However, our pragmatic age requires scientists not only to advance deeper, to understand the molecular foundations of life but also to update fundamental ideas about man and humanity.

The classification of sciences is not a frozen doctrine. It evolves in the course of the historical development of human civilization. So, Aristotle divided science into theoretical, practical and creative. In the XVIII century, the term “natural history” appeared. In our XXI century, nanotechnologies, Data Science and quantum calculations as independent directions are allocated.

The modern classification also has several urgent tasks requiring solutions. What categories should be assigned to hybrid sciences (for example, bioinformatics)? What is the relation to the phenomenon of the disappearance of the boundaries of digitalization (for example, AI is used both in medicine and in linguistics)?

In parallel with the evolution of scientific knowledge, a transformation of its ethical assessment takes place: where to include, for example, studies of genetic editing—to biology or philosophy?

The classification remains a living tool that adapts to time challenges, maintaining the role of "map" in the world of knowledge. The conceptual basis of the classification is closely related to the scientific paradigm of the modern era, which strives for the “progressively better (more accurate, more complete, more economical, more effective) representation, explanation, and prediction of natural reality” [1]. It is impossible to disagree with the opinion of W. Glänzel and A. Schubert [2] that “the classification of science into a disciplinary structure is at least as old as science itself. After many centuries of constructive, but so far, the only reasonable approach to the only reasonable approach to issue, is pragmatic: what is the optimal scheme for a given one for a given one Practical goal? ” [2].

The relevant topic is the search and development of a new universal methodological approach to the objective representation of the boundaries of the sphere of knowledge that humanity has mastered. Understanding these boundaries will extrapolate the direction of future research.

2. Object and subject of research

The subject of the study (subject) is the patterns of the emergence of new scientific areas in the modern world. The object of research is the possibility of logical and graphic interpretation of the formation of new scientific areas and their relationships.

3. Target of research

This study aims to choose the most adequate approach to understanding the determinism of the emergence of certain areas of science, and their cross-relations.

4. Literature analysis

A positive attitude to the need for the classification of sciences is confirmed by many studies. A review of such works allows us to highlight the following arguments in favour of such an analytical approach.

1. Optimization of knowledge structuring. Classification allows you to streamline various fields of knowledge. Allows you to divide the extensive array of information into logical blocks. Examples: natural sciences (physics, biology), humanitarian (history, philosophy) and technical (engineering, IT). This helps scientists and students easier to navigate in a large amount of information. Simplifies navigation in scientific space: the researcher knows exactly which field his work belongs to [3].

2. Structuring sciences reveals their specialization, which allows researchers to focus on a particular field and deepen their knowledge. Such a division of sciences into groups contributes to a deeper study of individual disciplines [4]**.**

3. Classification helps to see differences and connections between sciences. A similar approach contributes to the development of interdisciplinary research and the integration of knowledge. For example, biology can intersect with chemistry and ecology [5].

4. The formation of the methodology of cognition is also a strong argument in favour of the classification of sciences. It is known that each science has its own subject and research methods. The classification allows you to determine which approaches and methods will be the most suitable for studying a particular field: for physics, an experiment; for philology, hermeneutics [6, 7].

5. The formation of educational processes. The classification system is used in educational institutions to create curricula and courses, ensuring the logical construction of the educational process, that forms the basis for curricula. Helps students see the relationship between disciplines (for example, biochemistry combines biology and chemistry). The study of clinical disciplines by students of medical faculties is preceded by the study of the normal and pathological anatomy of a person, histology, normal and pathological physiology and bioethics [8].

6. Synergism of scientific communications. Generally accepted classifications facilitate the exchange of information between scientists of different disciplines. This is especially important in studies requiring cooperation between specialists from different fields, in the formation of interdisciplinary research or multidisciplinary groups. Structuring the system of cognition reveals “white spots” at the junction of sciences, which gives rise to new directions. For example, neurolinguistics (language + brain); space medicine (biology + astrophysics) and CRISPR technologies as a synthesis of genetics, biochemistry and microbiology. In healthcare, the creation of the Palliative Assistance Institute requires the joint work of psychologists, anesthesiologists, theologists and social workers [9].

7. The economic and managerial feasibility of structuring sciences is that government and private organizations use classifications to determine priorities in scientific research and financing. This allows you to more effectively distribute resources. An assessment of the economic and managerial feasibility of structuring sciences includes an analysis of economic restrictions and variable contexts that affect the organizational structure. Studies can be aimed at assessing the possibility of development, for example, the faculty of management and economics [10].

Thus, the classification of sciences plays an important role in simplifying and systematizing knowledge, which contributes to their development and put into practice. However, the question arises of optimizing this process.

Modern sciences are classified according to various grounds, for example, by the subject and method of cognition. Science is divided into natural, technical, social (social), and humanities. There are also various hierarchical ideas about the classification of sciences, such as the "staircase of sciences" [11].

This, obviously, endless growth in the differentiation of scientific knowledge should not inhibit the same endless improvement of existing scientific areas and related practices. Ralph E. Gomory warned about the possibility of such risks at the end of the 20th century [12].

It can be assumed that the first scientist who noticed the threat of the separation of knowledge was the French philosopher Auguste Comte, who published his work “System of Positive Polity: or Treatise of Sociology—a Positive Policy System, or a Treatise of Sociology," in which he presented a hierarchical classification of sciences that did not lose its significance and a treatise [13].

The basic or fundamental sciences indicate mathematics, astronomy, physics, chemistry, biology and sociology. Hierarchical relationships, according to stake, must meet the following criteria:

1. Chronology of the emergence in the history of mankind;

2. The presence of a logical relationship of the emergence of a new science from the previous stage;

3. The growing complexity of the subject area of the new sciences;

4. Reducing the degree of their community in the process of development.

A similar approach led to the idea that at the lower level of the hierarchy there are the simplest and least dependent sciences, and more complex and dependent sciences occupy higher

places (Fig.1) .

As can be seen from the above drawing, reflecting the sequence of the emergence of the basic sciences as human civilization develops, there was an urgent need for a moral assessment of the process of cognition.

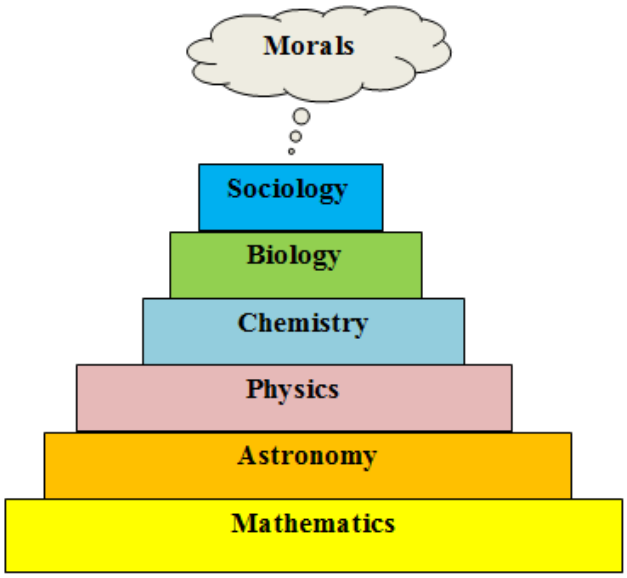

Fig. 1. Hierarchy of science on A. Comte [13].

5. Research methods

In this study, hierarchical and structural-functional approaches (SFP) were used. When choosing the methods, they proceeded from the fact that SFP focuses on the functions of each unit of the system in the context of the entire system, which allows us to understand the relationship between elements and their role in maintaining a scientific knowledge system.

The article justifies a conceptual transition from a generally accepted ontological approach to ethical pluralistic spatial classification.

6. Research results

The historical approach to the development of science allows us to distinguish the first scientific areas, which, in the future, did not remain isolated “knowledge containers" but widely communicated with other directions (table 1).

Table 1. Chronology of the main scientific areas and research methods

Historical stages	Scientific directions and methods
1. Antiquity (V century BC - IV century AD).	For this centuries-old period of the development of civilization, mathematics (Pythagoras, Euclid), philosophy (atomism of Democritus) and astronomy (geocentric model) were developed. The leading scientific method was direct observation of the world around the world and the logical apparatus of thinking (classical logic).
2. Middle Ages (V - XV centuries)	Sciences: scholasticism (synthesis of theology and logic), alchemy, medicine (herbalists, humoral theory). The leading method is the authority of texts (the Bible and the teachings of Aristotle).
3. Revival and Education (XVI - XVIII centuries)	Sciences: Heliocentrism (Copernicus, Galileo), Physics (Newton), Chemistry (Lavoisier). Method: Experiment + Mathematization.

Continuation of Table 1

4. Industrial era - XIX century	Biology (Darwin), thermodynamics and sociology (Comte, Marx). Method: evolutionism, dialectics.
5. The era of global challenges - XX century	Sciences: quantum physics, genetics (DNA opening), cybernetics. Method: interdisciplinary
6. Digital era —XXI century (until 2025)	Sciences: artificial intelligence, CRISPR editing of the genome, neurotechnology. Method: Big Data, algorithmic modeling.

As we can see, the periodization presented in Table No. 1 also includes 6 levels of the hierarchy of sciences by A. Comte, presented in Figure 1. Mathematics is the lowest level in the hierarchy of sciences by A. Comte, while sociology occupies the highest. The hierarchy of this classification is as follows: order: (a) mathematics, (b) astronomy, (c) physics, (d) chemistry, (e) biology and (f) sociology.

In general, this sequence is close to the historical sequence of sciences, but the content of hierarchies is much deeper than a simple constitution of the dates of the birth of certain sciences.

The categorization proposed by A. Comte makes it obvious that the simplest and least dependent sciences are at the lower level of the hierarchy, while the most complex and dependent sciences are upstairs. Sociology, according to Contain, is the "crown of the superstructure" of the scientific hierarchy. He did not mean that it surpasses other disciplines; instead, he had in mind that it helps to put other sciences in the context of the intellectual history of mankind.

A similar, but much more extensive hierarchical construction of knowledge classification is represented in Universal Decimal Classification (UDC) [14], which appeared as a result of the further development of the "decimal classification" of M. Dewey. She maintained the hierarchical principle of structuring an array of information. At the same time, several features and techniques characteristic of the analytical and synthetic classification were introduced in the UDC. In the numerous sections of this system, many concepts are streamlined in all branches of knowledge or activity. In other words, UDC covers the entire universe of knowledge. UDC Is One of the Most Widely Used Classification Schemes for All Fields of Knowledge. It is used in libraries, bibliographic, documentation, and information services in over 130 countries around the world and is published in over 40 languages [14].

One of the main distinguishing features of universal decimal classification is both the most of the main and auxiliary tables by the principle of division from general to the particular decimal decimal code.

UDC is universal and in use. Thanks to the abundance of indexing means and techniques of easily reduced fractionals, it is successfully used to systematize and subsequently search by scientists and students for the most diverse sources of information in various volumes and purposes of funds—from small, narrow-minded assemblies of special documentation to large industry and multi-industrial reference funds.

UDC Consortium (UDCC, Owner of the UDC International System, Netherlands) has developed abbreviated UDC tables in English (UDC Summary). Reduced UDC tables have more than 2000 headings. They contain basic classes (sections, units) and general and special determinants. As a rule, in the main table, the concepts, specific to the defined areas of science, technology, art, etc., are equipped with only their peculiarities. The main series of the UDC classifier includes the main consensus (the 4th section is closed).

1 Philosophy. Psychology
2 Religion. Theology (theology)
3 Social Sciences
5 Mathematics. Science
6 Applied Sciences. Medicine. Machinery
7 Art. Decorative and crafts. Games. Sport

8 Language. Linguistics. Linguistics. Literature

9 Geography. Biographies. History

Despite the well-established multi-year authority of the UDC system, there is doubt about the advisability of such an approach. Jens-Verik Mai calls this approach "naive." He believes that a reliable theory of classification does not share what things are and the cognitive constructions of people about what things are [15].

Classification should not share the ontology of the belief and the epistemology of how we learn about things. “Globalization of the classification distracts attention from the direct context and needs of the local community and replaces the locality of the classification for standards, effectiveness and international exchange of bibliographic records. The purpose of the global classification is the presentation of things as they are, the consideration of documents as decontextualized containers of information material that can be analyzed and described neutrally and scientifically, following a pre-planned, rational and systematic approach ”[15]. In the framework of the above modern requirements, the following situational classification of sciences is proposed, reflecting modern ideas in terms of fundamentalism and objects of research (tables 2 and 3).

Table 2. Classification of sciences in terms of fundamental

Level	Examples of sciences	Characteristic
Meta-hunkers	Philosophy, logic	Study the methods of cognition themselves
Basic	Physics, mathematics	Universal laws of the universe
Synthetic	Biophysics, chemical geology	Integration of 2-3 disciplines
Applied	Engineering sciences, medicine	The practical application of theories

Table 3. Classification of sciences by object of research

Types of sciences	Subject and object of research
Natural	Physics, chemistry, biology (nature study)
Social	Economics, sociology, political science (human communities)
Humanitarian	Philosophy, art history, linguistics (culture and meanings)
Formal	Mathematics, computer science, statistics (abstract systems)

It should be noted that the dialectic of scientific development teaches us to look into the future. It already signals human civilization with new challenges—trends of the 21st century.

1. Convergence of NBIC technologies:
   - Nano (materials science)
   - BIO (General Engineering)
   - Info (quantum calculations)
   - Cogno (neuro interfaces)
2. Revolutionary changes to methodologists:
   -The fourth paradigm (this-oriented science):
   - CERN: 30 petabytes/Year of data with tank
   - AlphaFold: Prediction of 200 million protein structures
3. The emergence of new disciplines:
   - Cliodinomics: mathematical modelling of historical processes
   - Astrobiology: Search for life outside the Earth + synthetic biology.

Descriptive traditional models of classification by strings can be adjusted to a changing reality. Dynamic expanding global processes, with their mutual penetration and the birth of related sciences, better reflect the dynamic interference model, reflecting the present and the future. When crossing waves of the influence of one science of zones of the influence of other sciences. Their intersection gives birth to the future related sciences (Fig. 2).

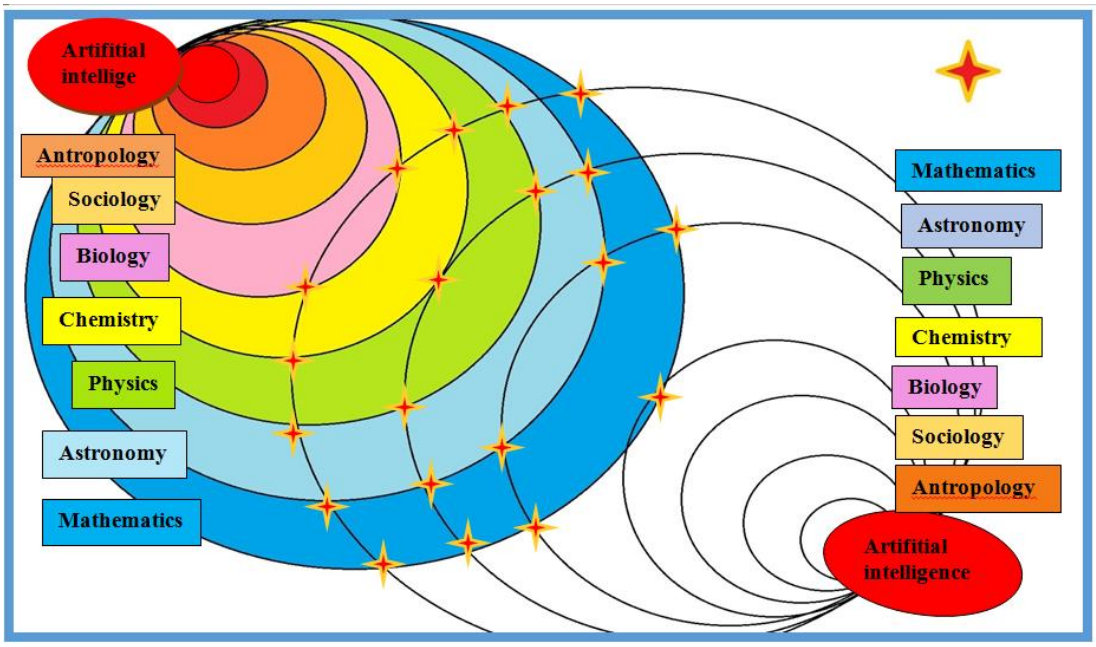

Fig. 2. Interference approach to forecasting the structures of scientific knowledge. Stars on the intersection lines of sciences indicate existing and future border or related sciences.

7. Prospects for Further Research Development

Further studies should show that the real, relevant hierarchy of sciences should discard the image of the hierarchical staircase and take the form of a neural network with cross-bonds, where breakthroughs arise at the joints of disciplines. With this approach, mathematics remains the “queen of sciences," but its power is now shared with the Computer Science and Complexity Theory.

8. Conclusion

In recent years, rapid scientific progress has led to the creation of artificial intelligence technology, which created the conditions for the rapidly accelerating scientific progress and intellectual development of mankind.

But the most important was not only the use of artificial intelligence to accelerate human scientific activity, but also the emergence of the possibility of independent creative activity, which has opened up new opportunities for the intellectual and technological development of mankind. However, this is what led to the emergence of a fundamentally new ethical problem for the entire civilizational process.

Starting with a model of science proposed by O. Comte, an ethical component of assessing the knowledge of a person and their orientation remains relevant. The analysis of the scientific sphere should not only state the existing level of the level but, based on dynamic models, predict the possible appearance of new startups, controlling them within the framework of the ethical norms of our time**.**

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