UDK 001
DOI: 10.20535/2077-7264.2 (72).2021.226326

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CRITERIA FOR DEMARCATION OF PSEUDOSCIENTIFIC KNOWLEDGE, CHANNELS AND CONSEQUENCES OF ITS DISSEMINATION

The criteria for distinguishing between scientific and pseudoscientific information have been studied. The scientific activity as a system is characterized, its goals and the principles of scientific discussion are highlighted. The role of the media in the dissemination of pseudoscientific information was emphasized and the consequences of such dissemination for individuals and the whole society are highlighted.

Keywords: pseudoscience; parascience; quasi science; antiscience; scientific publications.

Formulation of the problem

Pseudoscience is defined by its relation to science and involves subjects that are either on the margins of science and are not proven, or have been disproven, or make claims that sound scientific but in fact have no relation to science [1]. Pseudoscience causes dreadful effects, both for the individuals who believe it and for the whole society. So-called science channels are bombarded with aliens, ghosts, cryptids and miracles as though they are undisputable facts [2]. Globally, the problem of a Google patient is acute when people detect and treat diseases, not by consulting doctors, but trusting only Internet sources. People take slimming pills that have not been clinically tested, consume an unjustified amount of vitamins, clean the bodies of toxins. Patients with terminal illnesses lower their survival chances by endorsing complementary and alternative medicine instead of conventional evidence-based therapies [3]. Additionally, refusal of vaccination causes outbreaks of avoidable diseases [4].

Irrational beliefs become more relevant 'by dressing up as science, in the sense that they are more likely to grab people's attention, to be remembered and cognitively processed, and to be disseminated' [5, P. 86]. So, the problem of delimitation of scientific and pseudoscientific knowledge is extremely relevant all over the world.

Analysis of previous studies

There is no clear line dividing sense from nonsense. For example, alchemy was a reputable science in the times of Newton and Boyle, but now it is pseudoscience [6]. L. Loudan says that the difference between science and pseudoscience lies in the validity of the theory [7]. According to the Oxford Dictionary, pseudoscience is 'a collection of beliefs or practices mistakenly regarded as being based on scientific method' [8].

P. Thagard highlighted such characterize of pseudoscience as stagnation, primitive thinking by analogy, disregard for empirical data and alternative theories, complexity of theories, presence of numerous 'ad hoc' hypotheses [9]. We also can distinguish pseudoscience from science with such indicators as lack of falsifiability, misuse of scientific vocabulary, absence of connectivity, sensational claims, arguments from authority and lack of self-correction [10].

There are differences between pseudoscience and fraud in science. A researcher who reports 'better' results is criticized, but such results are not pseudoscientific. In this case a deviant doctrine is missing. Pseudoscience involves the promotion of claims that contradict results from mainstream science [11, 12].

M. Kazakov distinguishes four types of the transformation of scientific knowledge: parascience, quasi science, pseudoscience and antiscience. In history, it can be a disregard for chronology and historical sources, in physics the introduction of non-existent constants, laws, formulas and concepts etc. Parascience is an attempt to solve scientific problems in ways alternative to what science offers. Most often, these decisions are based on spontaneous evidence. Quasi science is an imitation of scientific activity and the results obtained follow the general norms of scientific research (at the same time a completely inconsequential question is investigated, or the results are not different from the results previously achieved in other studies). Pseudoscience contradicts scientific knowledge and scientific worldview (for example, the discussion between supporters of scientific creationism and evolutionism, where creationism acts as an alternative scientific theory). Antiscience is a set of ideas and social initiatives deliberately directed against the scientific community to discredit science and scientists. Antiscience includes, for example, conspiracy theories [13].

The **aim** of this **article** is a) to provide an overview of what science is and is not; b) to highlight the criteria for the evaluation of pseudoscience.

Results of the research

Science, in the most general sense, is the human practice that provides us with the most reliable knowledge that we have access to on a wide range of subject matters [13]. Science works with hypotheses to explain facts, and the more hypotheses science rejects, the closer the scientist gets to a scientific explanation [14].

A fundamental strength of science is its mechanisms for self-improvement, not only in its specific results, but in methodological approaches. The researcher who tries to perform good science but fails,

ISSN 2077-7264. Технологія і техніка друкарства. 2021. № 2(72)

ISSN 2077-7264. Технологія і техніка друкарства. 2021. № 2(72)

for instance due to equipment failures or statistical mistakes, is still a scientist, not a pseudoscientist [15].

Science is a five-dimension system involving:

1) an *ontological postulate* founded on the rejection of explanations or justifications calling upon tradition;

2) a *method* founded on the formulation of falsifiable hypothe-ses that specify the conditions of their falsification;

3) a *systematized body of knowledge* established by the consensus of the scientific community;

4) 5an *institution* structured around its own rules, procedures and actors;

5) a *social construct* that always seeks to embody completeness [16].

According to D. Koshland, there are three types of scientific discoveries: charge, challenge, and chance. An example is Newton's discovery of gravity (someone who understood the nature of the phenomenon that was in front of everyone's eyes). An example of chance is the sudden discovery of penicillin by Fleming (a scientist broke pasteurization rule by accident). The challenge is that the scientist sums facts and studies that have been accumulated over time. Examples of challenge are Einstein's special theory of relativity, the discovery of a double DNA structure by Francis Crick and James Watson. These discoveries were preceded by several studies of predecessors [17].

The purpose of basic science is to clarify the objective laws of nature (in the broadest sense of the word, including the laws of society). The aim of applied science is to develop new technologies and materials for specific engineering and technical purposes [18].

Pseudoscientific convictions were shown to be associated with belief in paranormal and conspiracy theories [19]. Moreover, people who accept a conspiracy theory are more willing to accept another, even if the theories contradict each other [20].

Pseudoscientists use: media that needs sensations and flashy headlines, trolling and bots in social networks, demagoguery techniques, attacking the character, motive, or some other attribute of the person rather than attacking the substance of the argument itself, intimidation of opponents (administrative pressure, death threats, court, criminal prosecution, anonymity, etc.), active use of patriotic rhetoric and topical political slogans that have nothing to do with the author's ideas, seeking patronage from politicians and high-ranking officials [18]. Pseudoscientists also use scientific publications, language, and typical features such as graphs and formulas, to convince people that they are dealing with science. Pseudoscientific concepts are pervasive, and people lack the motivation to correct their intuitive beliefs, but instead try to confirm them and use to ignore genuine scientific expertise [5].

M. Kazakov named 15 properties that characterize perverted forms of scientific knowledge:

1. Use of mythological, religious, or political attitudes in research work, appeal to the personal authority of people who are far from science.

2. Referring to concepts, theoretical systems or ideal objects that do not have sufficient grounds for their introduction into scientific theory, even as ideal objects, algorithms for building a formal system, model, etc.

3. The absence of any result for a long time (evidence or refutation of the theory) in applied research.

4. The inability to disprove or confirm the theory.

5. Ignoring certain facts of physical reality that are not in accordance with the picture of the world offered by the author of the pseudoscientific concept or adjusting the facts and theories of science to the picture of the world formulated by pseudoscientists.

6. An appeal to the authority of a scientist or an influential person in society instead of a reference to specific scientific facts.

7. Excessive use of scientific terminology, attributing to scientific terms meanings different from conventional.

8. The presence of logic-epistemological pathology, an attempt to explain the world and present the problems of other sciences in the language of a highly specialized, and in some cases also false theory.

9. Claims of uncompromising, rapid, and innovative positive results, which science is unable to achieve at all or now.

10. Victim strategy of thinking (the author's attempts to expose himself to a conspiracy, envy or conservative attitudes attributed to science).

11. Appeal to the media instead of the scientific community.

12. Finding and creating arbitrary links between real phenomena and processes.

13. Intolerance of a particular pseudoscientist to alternative theories, both scientific and alternative pseudoscientific.

14. Excessive complication of easy explanations or, conversely, excessive relief of explanations, use of mathematical language to impress.

15. The lack of mass adoption and commercial use of the proposed practice or technology [13].

A. Derksen proposed two criteria for the evaluation of pseudoscience. The first criterion is the criterion of falsification of K. Popper. Hypotheses and theories should be tested to increase scientific knowledge. The second criterion is the validity of knowledge as a necessary condition for distinguishing between science and pseudoscience [21].

On the basis of these two criteria, A. Derksen highlighted seven 'vices' of pseudoscientific knowledge: 1) a lack of sufficient justification (with insufficient evidence, the theory remains speculative); 2) unreasonable immunization (only a special interpretation of the data is acceptable; the theory is immunized if critical arguments are rejected without sufficient justification); 3) super-taste by a sensational coincidence (attempt to uncritically comprehend, at first glance, sensational coincidences); 4) the magic method (using the method of free associations); 5) a small number of people who know 'the truth'; 6) an all-encompassing theory that has a ready answer to everything that happens; uncritical and inadequate requirements. The worst violations are the inability to provide sufficient argumentation and the inability to be self-critical [21].

ISSN 2077-7264. Технологія і техніка друкарства. 2021. № 2(72)

ISSN 2077-7264. Технологія і техніка друкарства. 2021. № 2(72)

Since 2016, the U.S.-based Chapman University has conducted surveys on the paranormal beliefs of the USA population. According to its latest survey, 58 % believed in ghosts, 57 % that a high-technology civilization existed in the past, 41 % that aliens have influenced the development of ancient societies, 35 % that aliens are among us, 26 % that it is possible to move objects with the power of the mind, and 17 % in mediums and fortune-tellers. If a quarter declares 'no beliefs', more than 60 % entertain 'multiple' beliefs. So, a large segment of the population is uneducated, lacks critical judgment and has not assimilated the basics of the scientific method [22].

Pseudoscientific beliefs such as climate change denial, homoeopathy, quantum quackery, magnet therapy, HIV/AIDS denialism, anti-psychiatry, parapsychology, body memory and the anti-vaccination movement [19] are characterized as lacking 'the totality of evidence and knowledge that is available to human knowledge seekers at the time in question' [23].

There are at least three diagnostic signs of pseudoscience. The first of them is cherry-picking. Single facts can be picked out that may seem, if considered alone, to support a conclusion at odds with what follows from the full system of evidences that have to be evaluated in their entirety. For instance, some geological findings, can disprove evolutionary theory [24]. The second characteristic is neglect of refuting information. Pseudoscience lacks the intellectual and social mechanisms making people to change their views in response to new evidence. As a result, refuted claims have a remarkable survivability in pseudoscience. For instance, homeopathy is still based on principles from the late eighteenth century that were disproved by discoveries in chemistry in the early nineteenth century [15].

The third characteristic is deviant criteria of assent, the process by which new standpoints in scientific issues become accepted by the scientific community. Scientific assent means that a claim becomes provisionally not doubted. In other words, science does not accept an empirical claim for ages [15].

There are two psychological factors giving pseudoscience an advantage: confirmation bias and anti-expertise. Confirmation bias makes people prefer the 'scientific' theories that rationalize their intuitive beliefs. Anti-expertise is distrusting of recognized experts, and it supports pseudoscience too [5].

In pseudotheory promotion, the most common attitude is avoidance of conflicts. For instance, advocates of homeopathy use to avoid conflicts with conventional science. They claim that their practices are consistent with medical science and evidence-based medicine, in the sense that the two 'paradigms' can peacefully coexist without any conflict [15].

Many scientists decide to communicate science publicly, especially on the Internet, to support the science and to influence the implementation of public policies. They usually correct misconceptions held by the media when covering scientific topics or disprove antiscientific views [25].

At the same time pseudoscientists create institutes, conferences,

websites, and pseudoscientific journals that do not satisfy the basic quality criteria of science. Many broadcasts on TV are served as real events, such as 'Battle of psychics', misleading people who watch them. The media fulfill the social order of mass culture. Various talk shows attract astrologers, soothsayers, chiromans, founders of schools of personal development. But all kinds of pseudoscientists are unsuccessful in publishing in peer-reviewed scientific journals [15].

Ukraine has now developed a system of financing science on the principle of competitive distribution of funds, but the criteria for such distribution often remain purely formal quantitative indicators. Even the requirements for publishing articles in journals belonging to international scientometric databases do not guarantee that the publication of dubious content will not be published in a predatory journal without proper peer review.

Conclusions

Simultaneously with the growing importance of science and the widespread development of high scientific technologies, in everyday culture there are such trends as: universal profanity of science, high level of superstition of the population, pathological susceptibility to cognitive distortions. The category of pseudoscience does not have clear boundaries but it is related to science denialism (climate change denialism, relativity theory denialism, vaccination denialism, etc.), and conspiracy theories.

One of the main factors of popularity of pseudoscience is a deep cultural crisis, criticism of the existing paradigms of worldview. People use to believe that pseudoscience provides a worthy alternative of science. The lack of critical thinking, methodological basis of scientific validation plays a decisive role. Pseudoscientists are trying to attract media attention, to call the media and the public interest. Focusing on the ordinary consciousness, the pseudoscientists spread their ideas through the media system, gaining fame and material benefit.

Science builds theories to explain the whole set of objective experimental facts, operating a strict system of principles and approaches to research, and pseudoscience picks up those facts that confirm speculative theory and ignores all others. In scientific discussions there is a taboo on subjectivity, demagoguery, threats, administrative, political, and legislative pressure, etc. The aim of the real scientist is to find the truth and make scientific disputes as objective as possible. At the same time pseudoscientists use to avoid scientific discussion. Pseudoscience undermines the authority of normal science, disorients society, and damages business.

The best way to evaluate the work of a particular scientist is to see how it is evaluated by the scientific community and how often it is cited compared to other researchers working in the same field. Those who want to know reliable information about research and reliable facts should read western peer-reviewed scientific journals. However, this should be done with caution because the reader may misinterpret the information. Any scientific news must contain a reference to the source (an article in

ISSN 2077-7264. Технологія і техніка друкарства. 2021. № 2(72)

a scientific journal or an official press release of the scientific institute or university where the discovery was made). If the source is not specified, then the news is questionable.

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ISSN 2077-7264. Технологія і техніка друкарства. 2021. № 2(72)

Досліджено критерії розмежування наукових і псевдонаукових тверджень. Схарактеризовано наукову діяльність як систему, її цілі та виокремлено принципи ведення наукової дискусії. Описано технології, які використовують псевдонауковці, щоб вплинути на громадську думку.

Ключові слова: псевдонаука; паранаука; квазінаука; антинаука; наукові публікації.

Надійшла до редакції 09.03.21