

Lecture notes 1

Concept of science. Classification of sciences. Steps of research process

This may be the first time you are doing scientific research. Your Ph.D. thesis will reflect all the stages of your research. There is a big difference between a master and Ph.D. thesis. The main difference is that you are doing scientific research that must be new, relevant, and practically meaningful. The novelty of the research means that you have to not only use well-known methods to solve a specific problem, but also do something that no one else has done before. To meet this challenge, you need to have a clearer understanding about a place of your research among others and be able to organize your research. This lecture will help you with this.

Let's start with terminology

Science (from the Latin word *scientia*, meaning "knowledge") is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe

Scientific research is the search for knowledge and for solutions to practical problems using this knowledge (often driven by curiosity)

Scientific method seeks to objectively explain the events of nature in a reproducible way

The main stages of a scientific method:

an observation,

a hypothesis,

a test (i.e. the experiment that tries to simulate natural events under controlled conditions as appropriate to the discipline)

Experimentation is especially important in science to avoid the correlation fallacy.

If the hypothesis survived testing, it may become a scientific theory, a logically reasoned, self-consistent model for describing the behavior of certain natural phenomena.

A theory describes the behavior of much broader sets of phenomena than a hypothesis. In fact, a theory is a hypothesis explaining various other hypotheses.

Steps of Research Process

- Step One: Define research problem
- Step Two: Review of literature
- Step Three: Formulate hypotheses
- Step Four: Preparing the research design
- Step Five: Data collection
- Step Six: Data analysis
- Step Seven: Interpretation and report writing

The role of mathematics is crucial for science

It is essential in the formation of hypotheses and theories

It is used in quantitative scientific modeling, which can generate new hypotheses and predictions to be tested.

It is used in observing and collecting measurements.

Statistics, a branch of mathematics, is used to summarize and analyze data, which allow scientists to assess the reliability and variability of their experimental results.

Computational science applies computing power to simulate real-world situations, enabling a better understanding of scientific problems than formal mathematics alone can achieve.

So, let's talk about the **basic requirements for research organization**

While performing experiments to test hypotheses, scientists may have a preference for one outcome over another, and so it is important to ensure that science as a whole can eliminate this bias.

This can be achieved by careful experimental design, transparency, and a thorough peer review process of the experimental results as well as any conclusions.

After the results of an experiment are announced or published, it is normal practice for independent researchers to double-check how the research was performed, and to follow up by performing similar experiments to determine how dependable the results might be.

Thus, all results must be reproducible,

Scientific ethics must be respected

i.e. falsification or fabrication of results and plagiarism are strictly prohibited.

How to identify the type of your research? Any scientific research can be labeled as either basic or applied research

Basic science also called fundamental science has the scientific research aim to improve scientific theories for improved understanding or prediction of natural or other phenomena.

Applied science is the application of scientific knowledge transferred into a physical environment (testing a theoretical model through the use of formal science, solving a practical problem through the use of natural science).

Scientific research can be basic or applied

Basic research is the search for knowledge

Applied research is the search for solutions to practical problems using this knowledge.

You should remember that great deal of human understands comes from the curiosity-driven undertaking of basic research.

This leads to options for technological advance that were not planned or sometimes even imaginable.

This point was made by Michael Faraday when allegedly in response to the question "what is the use of basic research?" he responded: "Sir, what is the use of a new-born child?"

In addition to this classification, science is divided into branches

The branches of science, also referred to as sciences, "scientific fields", or "scientific disciplines," are commonly divided into three major groups:

Formal sciences: the study of logic, mathematics, which use an a priori, as opposed to empirical, methodology.

Natural sciences: the study of natural phenomena (including cosmological, geological, physical, chemical, and biological factors of the universe).

Natural science can be divided into two main branches: physical science and life science (or biological science).

Social sciences: the study of human behavior and societies.

Example fields of applied science

Natural, social, and formal science make up the fundamental sciences, which form the basis of interdisciplinary and applied sciences such as:

Engineering

Applied mathematics

Applied physics

Medicine

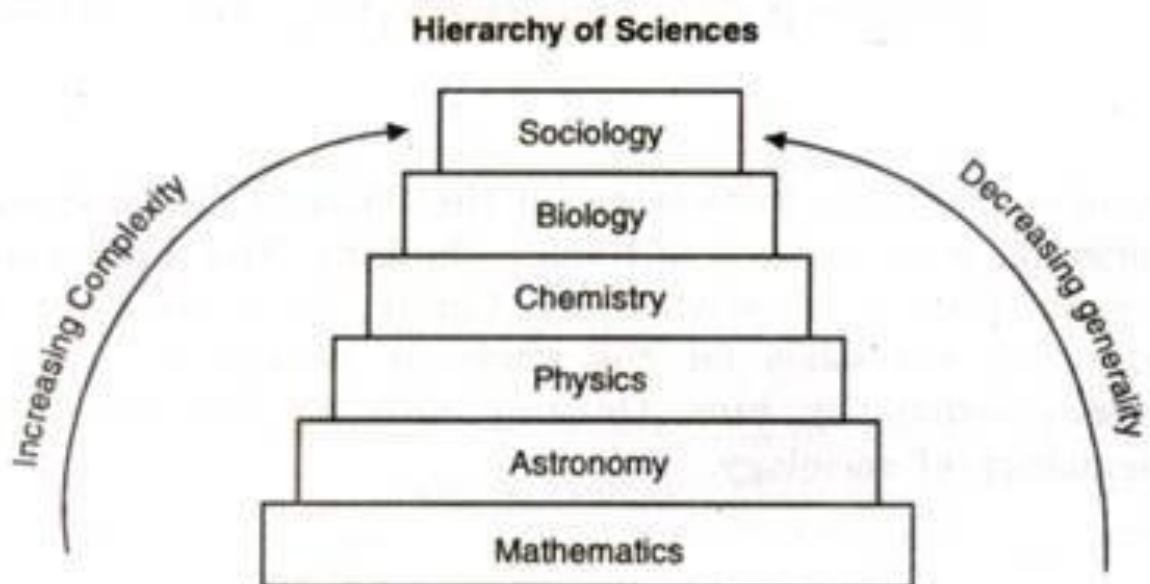
Computer science

Applied science focuses on the development of technology and techniques.

In contrast, basic science develops scientific knowledge and predictions.

Applied and basic sciences can interface closely in research and development.

If you look at the hierarchy of science, you must understand that mathematics, physics and astronomy form the basis for engineering sciences.



In simple terms, mathematics can do without sociology, and sociology cannot do without all the other sciences. The place of your discipline is above physics. Mathematics and physics are prerequisites for automation and control. Therefore, it is not surprising that we will look for the place of your research among others in the classifiers of scientific information in PACS

The Physics and Astronomy Classification Scheme PACS is a hierarchical subject classification scheme designed to classify and categorize the scientific literature.

PACS provides an essential tool for classification of scientific literature; as such, PACS is used by AIP (The American Institute of Physics) and other international publishers of journals

PACS contains ten broad subject categories subdivided into narrower categories. PACS also includes a topical alphabetical index with corresponding PACS codes.

To develop your skills in working with the heading lists (or rubricates) of scientific information required for international scientific journals, I ask you to use the PACS provided in the Tutorials and Additional Materials Section. PDF.

Your tasks for today are to

- 1) define as accurately as possible the headings (numbers-letters) of your master's research. There may be several of them, think and answer, why is it recommended to indicate several numbers?
- 2) indicate the title of your dissertation (in English and in Russian), the headings (numbers) that you have chosen for it (write down the names of these headings, not only indicate the numbers).
- 3) answer the question, what are УДК (UDC) and МРПТИ using the search on the Internet.
- 4) find and indicate the appropriate УДК and МРПТИ for your master's degree.

You have answer all 4 questions.

Your answer (PDF) should be emailed to the teacher by 5 p.m. today.