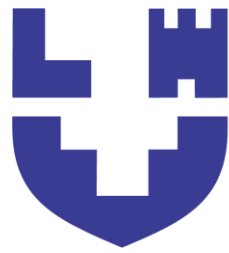


Міністерство освіти та науки України



ЛУЦЬКИЙ
НАЦІОНАЛЬНИЙ
ТЕХНІЧНИЙ
УНІВЕРСИТЕТ

***SCIENCE METHODOLOGY.
МЕТОДОЛОГІЯ НАУКОВИХ ДОСЛІДЖЕНЬ
(АНГЛІЙСЬКОЮ МОВОЮ)***

Навчальний посібник
для здобувачів другого (магістерського) рівня вищої освіти
освітньої програми «Технології та дизайн у модній індустрії»
спеціальності 182 Технології легкої промисловості
галузі знань 18 Виробництво та технології
денної та заочної форми навчання

Луцьк 2022

УДК 001.1+001.8+122/129+687.1

Р98

Електронна копія друкованого видання передана для внесення в репозитарій Луцького НТУ

Директор бібліотеки _____ С.С.Бакуменко

Рекомендовано до видання вченою радою факультету митної справи, матеріалів та технологій ЛНТУ, протокол № 2 від «__» вересня 2022 року.

Голова вченої ради факультету ММТ _____ В.В. Ткачук

Розглянуто і схвалено на засіданні кафедри технологій легкої промисловості ЛНТУ, протокол № 2 від «__» вересня 2022 року.

Завідувачка кафедри технологій

Легкої промисловості _____ Л.В. Назарчук

Укладач: _____ М. Л. Рябчиков, доктор технічних наук, професор кафедри технологій легкої промисловості ЛНТУ.

Рецензенти:

Олег ЛИТВИН –д.ф.-м.н., проф., завідувач кафедри Харчових технологій, легкої промисловості і дизайну Української інженерно педагогічної академії, м.Харків

Людмила ГАЛАВСЬКА – д.т.н.,проф., Начальник науково-дослідної частини., Київського національного університету технологій і дизайну

Відповідальний

за випуск Л.В. Назарчук, кандидат технічних наук, доцент, завідувачка кафедри технологій легкої промисловості ЛНТУ.

Science methodology. Методологія наукових досліджень (англійською мовою): навчальний посібник для здобувачів другого (магістерського) рівня вищої освіти освітньої програми «Технології та дизайн у модній індустрії» спеціальності 182 Технології легкої промисловості галузі знань 18 Виробництво та технології денної та заочної форми навчання/ уклад. М. Л. Рябчиков. Луцьк: ЛНТУ, 2022. 82 с.

Розглянуті основні питання методології наукових досліджень. Окремі розділи присвячені процесам підготовки наукових кадрів в Україні та світі, поняття наукового методу, основні риси діалектичної теорії пізнання. Описані об'єкт і предмет дослідження, основні методи дослідження. Зокрема описані дедукція та індукція, аналіз і синтез, системний підхід. Наведені основи теорії ймовірностей і математичної статистики, кореляційні і регресійні методи, методи експертної оцінки. Кожний розділ супроводжується завданнями для індивідуальної роботи, які формують уміння, а також викликають використання комунікацій і процесів формування суджень у здобувачів освіти.

© Рябчиков М.Л., 2022

CONTENT

Introduction	2
1.Training of researchers in Ukraine and the world	4
2. The concept of the scientific method	12
3.Investigation of the state of the question	20
4.The main features of the dialectical theory of knowledge	22
5.Character of development	25
6.The meaning of development	30
7.The object and subject of study	32
8.Basic research methods	42
9.Deduction and induction	49
10. Fundamentals of probability theory and mathematical statistics	53
11. Continuous random variables	56
12. Expert assessment methods	62
13. Analysis and Synthesis	68
14. Systemic approach	73
15.Structure of science article	78
Conclusions	81
References	82

Introduction

The purpose of studying the discipline "Methodology of scientific research with the foundations of intellectual property" is the formation of competences for independently setting and solving tasks of defining and implementing innovations, conducting scientific research and protecting intellectual solutions, taking into account modern research methods and tools.

The main tasks of the academic discipline "Methodology of scientific research with the basics of intellectual property":

- to gain knowledge about forms of scientific work, basic research methods, protection of intellectual property;
- to develop skills regarding theoretical and experimental research in light industry, protection of obtained scientific and technical solutions;
- ensure communication in the process of searching for scientific and technical information about the latest achievements in light industry using the state and foreign languages;
- to improve the processes of forming judgments regarding the latest results obtained in the research process;
- ensure the autonomy of conducting research independently or as part of a scientific team and responsibility for the obtained scientific results and technical solutions.

Competences are formed as a result of studying the discipline:

Ability to apply knowledge in practical situations.

Ability to plan and manage time.

Ability to communicate in a foreign language.

Ability to work in a team.

Ability to develop and manage projects in the field of production and technologies of light industry.

Ability to carry out safe activities in the field of production of light industry products.

The ability to show initiative and leadership qualities, to bear personal responsibility in the professional sphere.

The ability to make effective decisions and ensure the appropriate level of quality of work performed, safety and economic efficiency in the field of production and technologies of light industry.

The ability to apply resource-saving technologies to solve engineering and scientific problems in the field of light industry.

Learning outcomes expected by the discipline.

Have specialized conceptual knowledge, including modern scientific achievements in the field of production and technologies of light industry, sufficient for the production of new ideas and conducting research.

Plan scientific and/or applied research in the field of light industry technologies, choose effective research methods, process and analyze research results, justify conclusions.

Communicate freely in national and foreign languages orally and in writing on scientific, engineering and production issues in the field of light industry technologies, present the results of their activities.

Find information necessary for the development and implementation of scientific and innovative projects in scientific literature, patents, databases, other sources, evaluate, process and critically analyze it.

Use modern methods and equipment for experimental research of technologies, production processes, materials and products of light industry, apply relevant methods of planning and statistical processing of experimental data.

Independently acquire new knowledge and skills, help other team members in training.

Apply modern digital technologies during the design of light industry products and in scientific research.

1. Training of researchers in Ukraine and the world

There is a state system of organization and management of scientific research in Ukraine. This system provides an opportunity to concentrate and direct science to the fulfillment of the most important tasks, based on the needs of the socio-economic development of the state.

The state system of science management aims to develop strategic and tactical solutions for the implementation of fundamental and applied research, increase their efficiency, select the most promising scientific topics, provide research information, and economically stimulate their activity.

The legislative basis for the organization of science is created by the Verkhovna Rada of Ukraine. The executive body that develops and implements measures to implement a unified policy in the field of science is the Cabinet of Ministers of Ukraine, which is subordinated to institutions and organizations that carry out direct management of scientific activities in the state: the Ministry of Education and Science of Ukraine, the National Academy of Sciences of Ukraine, branch academies of sciences, sectoral and inter-sectoral ministries, committees and departments.

The organization of science in the state includes four main sectors:

- 1) academic - aimed at providing fundamental research that leads to the acquisition of new knowledge, ideas and theories;
- 2) university - aimed at providing fundamental and applied research that provides new knowledge and developments suitable for practical application;
- 3) sectoral - aimed at conducting applied research and implementation of developments and innovations;
- 4) industrial - related to the introduction of scientific and technical developments, improvement of equipment and technologies, thanks to which inventions are made, new equipment and new products are created.

The main goal of the educational system of Ukraine is the approach to global educational space. Common scheme of main items of such process is shown on fig.1

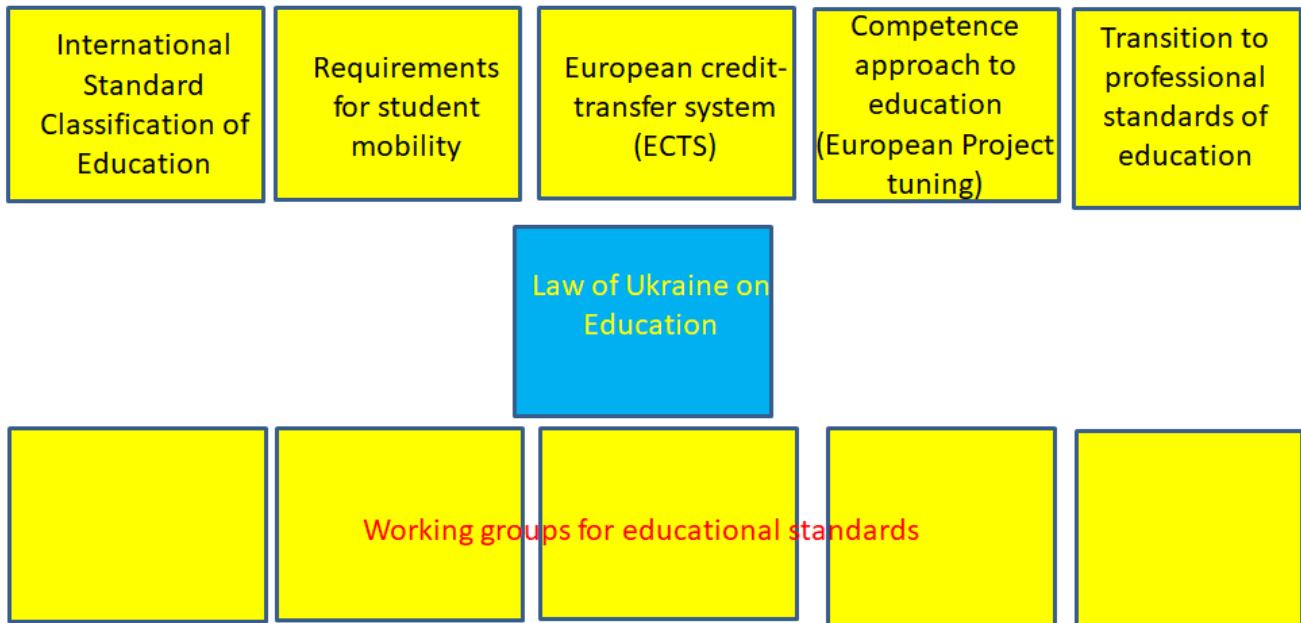


Fig.1 Approach of Ukraine to European educational system

International Standard Classification of Education defines nine levels

- 0-th level (the level of early childhood education)
- 1st level (the level of primary education)
- ...
- 6th level (equivalent bachelor level)
- 7th level (equivalent master level)
- 8th level (equivalent doctoral or equivalent level)

The levels of higher education that introduced in Ukraine

- initial (short cycle) - level 5
- the first (bachelor) - level 6
- second (Master) – level 7
- third (education and research) – level 8
- Science - level 9 (introduced additionally)

Higher Education Degrees in Ukraine

- - Junior Bachelor
- - Bachelor

- - Master
- - Philosophy Doctor (PhD)
- - Doctor of Science

Fields of education and science

(According to the International Standard Classification of Education)

- 0 - The general program;
- 1 - Education;
- 2 - Humanities and arts;
- 3 - Social sciences, business and law;
- 4 - Science;
- 5 - Engineering, construction and processing industry;
- 6 - Agriculture;
- 7 - Health care and social security;
- 8 - Service.

Classification of Occupations in Europe

Resolution Concerning Updating the International Standard Classification of Occupations

<http://www.ilo.org/public/english/bureau/stat/isco/docs/resol08.pdf>

- Major Groups
- 1 Managers
- 2 Professionals
- 3 Technicians and associate professionals
- 4 Clerical support workers
- 5 Service and sales workers
- 6 Skilled agricultural, forestry and fishery workers
- 7 Craft and related trades workers
- 8 Plant and machine operators, and assemblers
- 9 Elementary occupations

- 0 Armed forces occupations
-
- 132 Manufacturing, mining, construction, and distribution managers
- 1321 Manufacturing managers
- 1322 Mining managers
- 1323 Construction managers
-
- 134 Professional services managers
- 1341 Child care services managers
- 1342 Health services managers
- 1343 Aged care services managers
- 1344 Social welfare managers
- 1345 Education managers
- 1346 Financial and insurance services branch managers
- 1349 Professional services managers not elsewhere classified
-
- 214 Engineering professionals (excluding electro technology)
- 2141 Industrial and production engineers
- 2142 Civil engineers
- 2143 Environmental engineers
- 2144 Mechanical engineers
- 2145 Chemical engineers
- 2146 Mining engineers, metallurgists and related professionals
- 2149 Engineering professionals not elsewhere classified
-
- 216 Architects, planners, surveyors and designers
- 2161 Building architects
- 2162 Landscape architects
- 2163 Product and garment designers

- 2164 Town and traffic planners
- 2165 Cartographers and surveyors
- 2166 Graphic and multimedia designers
-
- 753 Garment and related trades workers
- 7531 Tailors, dressmakers, furriers and hatters
- 7532 Garment and related pattern-makers and cutters
- 7533 Sewing, embroidery and related workers
- 7534 Upholsterers and related workers
- 7535 Pelt dressers, tanners and fellmongers
- 7536 Shoemakers and related workers

Qualification “Professional in design, teacher of disciplines in the field of design” provides generalized objects of activity: the process of professional training of the person, artistic methods of obtaining finished products, providing its aesthetic significance.

Table 1

A specialist is trained to work in the field of economics under DK 009: 2010:

Section D	The processing industry, in particular
Subsection DB	Textile industry and tailoring
Subsection DC	Production of leather and leather shoes
Subsection DD	Manufacture of wood and wood products
Subsection DE	Pulp and paper industry; publishing
Subsection DH	Manufacture of rubber and plastic products
Subsection DN	Other production, not attributed to other groups
Section J	Information and telecommunications, in particular
Subsection JA	Publishing, Broadcasting and Television
Subsection JC	Computer programming and provision of other information services

Section O	Collective, community and personal services
Section R	Arts, entertainment and recreation

Table 2

The specialist is able to perform the specified professional work under DK 003: 2010:

Classification code of occupations	PROFESSIONAL TITLE OF WORK
2351	Professionals in the field of teaching methods
2149.1	Scientific staff (other branches of engineering)
2149.2	Engineers (Other Engineering Areas)
2452	Professionals in the field of fine and decorative applied art

Table 3

Primary posts for DK 003: 2010:

Classification code of occupations	Primary position
	<i>Scientific staff (other branches of engineering)</i>
2149.1	Researcher (Engineering)
2149.1	Junior Researcher (Engineering)
2149.1	Researcher-Consultant (Engineering)
2149.1	Researcher
	<i>Engineers (Other Engineering Areas)</i>
2149.2	Engineer
2149.2	Production engineer
2149.2	Design engineer
2149.2	Designer (other engineering field)
2149.2	Clothes designer
	<i>Professionals in the field of fine and decorative applied art</i>
2452.1	Designer researcher
2452.1	Art critic (fine arts and crafts)
2452.2	Modeling Analyst

2452.2	Designer (designer)
2452.2	Visagist Designer
2452.2	Graphic designer
2452.2	Designer Hairstyles
2452.2	Interior designer
2452.2	Designer of multimedia objects
2452.2	Fashion designer
2452.2	Designer packaging
2452.2	Designer of industrial products and objects
2452.2	Modeling Expert
2452.2	Designer
2452.2	Pattern maker
2452.2	Professional in hairdressing and decorative cosmetics
2452.2	Stylemaker
2452.2	Painter
2452.2	Artist of folk arts crafts
2452.2	Painter (model house)
2452.2	Fashion designer
2452.2	Artist-designer of game dolls
2452.2	Member of the board (artistic expert)

The main purpose - be able to work after graduating from university around the world

The first condition of unification - the transition to the European credit transfer system.

- Credit - a unit of measurement of student workload (includes lessons with a teacher, remote and independent work)
- For ECTS credit - 30 hours
- Norms for different educational levels
- Junior Bachelor - educational and professional program 90-120 ECTS credits

- Bachelor - educational and professional program 180-240 ECTS credits
- Master - 1) the educational and professional program 90-120 ECTS credits, 2) the educational and scientific program, 120 ECTS credits
- Doctor of Philosophy - educational and scientific program (4 years), the educational component of 30-60 ECTS credits
- Doctor of Science - Scientific Program

The transition to the competence approach to education:

- Competence is - dynamic combination of knowledge, understanding, skills, values, and other personal characteristics)
- A set of basic competencies to describe qualifications
 - - Knowledge;
 - - Ability;
 - - Communication;
 - - Autonomy and responsibility
- Communication - the relationship of the purpose of transmitting information, coordination, joint activities.
- Autonomy and responsibility - the ability to perform tasks, solve tasks and problems and take responsibility for their performance independently.

Basic requirements for scientific results

- Novelty
- The practical significance
- The validity of (the possibility to get a result in your specific conditions)

That is the first task for you (each point by one phrase)

1. *Learn surname scientific adviser*
2. *Determine the direction of research*
3. *Assess the possibility of novelty in terms of (the first time, to clarify, refine and develop)*
4. *Briefly estimated practical significance*
5. *What it is supposed to be used (disciplines which were learned, tools, etc.)*

2. The concept of the scientific method

The scientific method (or methods of scientific research) is a set of methods for establishing the parameters, structure, and other characteristics of the objects under study.

The method includes methods of researching phenomena, systematization, and correction of new and previously acquired knowledge. Conclusions are made using rules and principles of reasoning based on empirical (observed and measured) data about the object. Observations and experiments are the basis for obtaining data. To explain the observed facts, hypotheses are put forward and theories are built, on the basis of which conclusions and assumptions are formulated. The resulting predictions are tested by experiment or by gathering new facts.

An important aspect of the scientific method, its integral part for any science, is the requirement of objectivity, which excludes subjective interpretation of results. No claims should be taken at face value, even if they come from reputable scientists. To ensure independent verification, documentation of observations is carried out, availability of all raw data, methods and results of research is ensured for other scientists. This allows not only to obtain additional confirmation by reproducing experiments, but also to critically evaluate the degree of adequacy (validity) of experiments and results in relation to the tested theory.

Some parts of the scientific method applied by philosophers even of ancient Greece. They were developed some rules of logic and principles of dispute, the apex of which was the sophistry. Socrates is credited with saying that truth is born in a dispute. However, there was not so much a scientific truth is the aim of the Sophists as a victory in court proceedings where formalism higher than any other approach. In this case the findings obtained as a result of discussions, were favored in comparison with observed practice.

A famous example is Zeno, asserting that the fleet-footed Achilles will never overtake the tortilla

Hero easily runs through this part of the way, but at the time it took to overcome it, the turtle crawls on the distance a_1 . Achilles runs, and this segment, but the bug can travel a distance a_2 , and so on. It is understood that reason like that can be infinite, hence the need to overcome the Achilles infinite number of path segments, to which he will take an infinitely long time. Thus, concludes Zenon, Achilles will never overtake the tortilla.

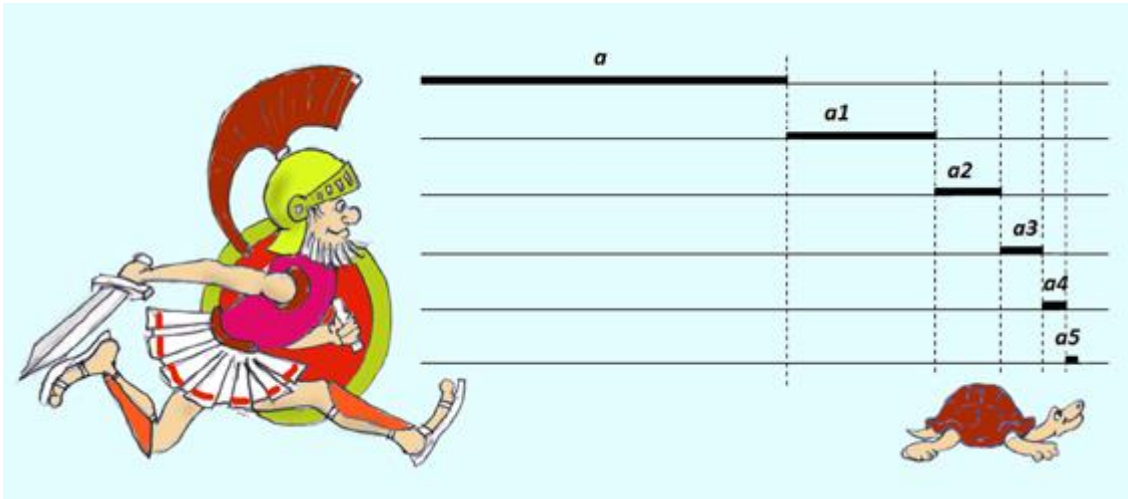


Fig.2 – Achilles and tortilla

Another example is Buridan's donkey. This donkey who dies of hunger, being between the same two armfuls of hay, because cannot choose one of them.



Fig.3 - Buridan's donkey

Paradox of delayed execution.

One Sunday, chief of prison called one prison, sentenced to death, and told him:

- You will be executed next week at noon.
- Day of the execution will be a surprise for you, you will learn about it only

when the executioner at noon will enter you into the camera.

The chief of prison was an honest man and never lied.

The prisoner thought about his words and smiled: "On Sunday, I can not be executed! It was already Saturday night I'll know about it. And, according to the head, I do not know the day of his execution. Consequently, the last possible day of my execution is Saturday. But if I can not be executed on Friday, then I will know in advance that I was put to death on Saturday, therefore, it can be deleted. " Consistently excluding Friday, Thursday, Wednesday, Tuesday and Monday, the prisoner came to the conclusion that the chief will not be able to execute him by running all his words.

Next week, the executioner knocked on his door at noon on Wednesday - it was a complete surprise to him. All that chief of prison said, was carried out. Where a lack of reasoning in prisoner?

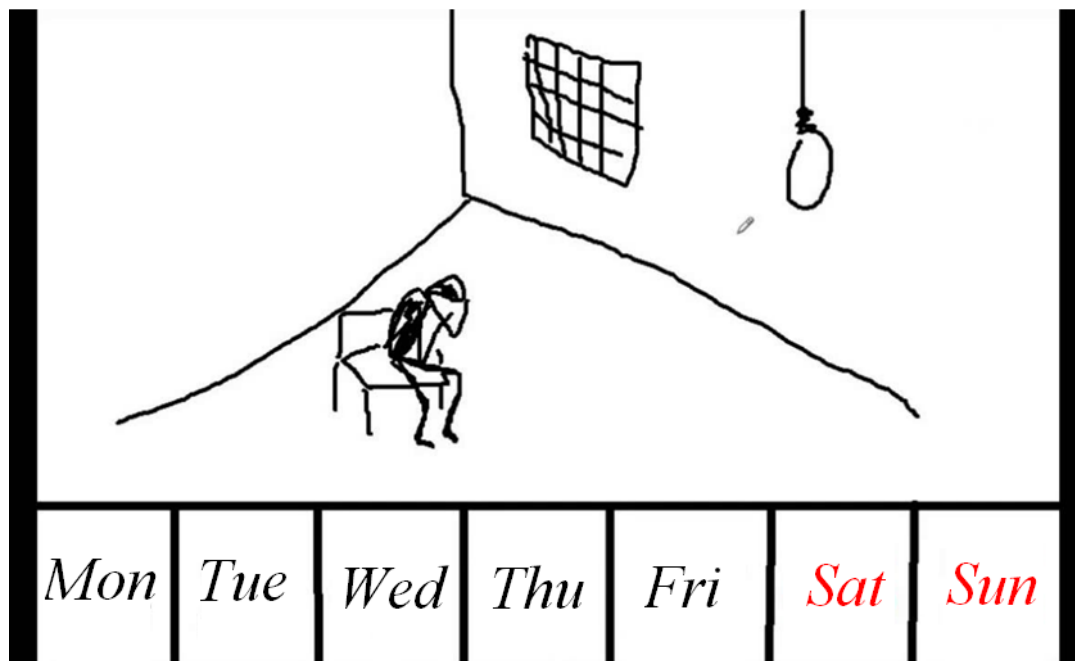


Fig.4 - Paradox of delayed execution

The task 2.

- *Think of sophistry that is associated with a visit to training, academic performance, work, homework, etc.*
- *Try not to write off!*

Example of household sophism.

The more I drink vodka, the more I shake my hands. The more I shake hands, the more alcohol I pour out. The more I pour out the less I drink. So, to drink less, it is necessary to drink more



Fig.5 - household sophism

In XX century it was formulated hypothetical-deductive model of scientific method, which consists in the consistent application of the following steps:

- 1. Use the experience: Consider the problem and try to make sense of it. Find previously known explanation. If this is a new problem for you, go to step 2.
- 2. Formulate a hypothesis: If none of the well-known does not fit, try to formulate an explanation, describe it to someone else or in their records.
- 3. Draw conclusions from the assumption: If the assumption (step 2) is true, some of it of the investigation, findings, predictions can be made according to the rules of logic?
- 4. Check: Find the facts contradicting each of these findings, in order to refute the hypothesis (step 2). Using the findings of (Step 3) as evidence of the hypothesis (step 2) is a logical fallacy. This error is called "confirmation of the result"

Fundamentals of the scientific method are shown on fig.6.

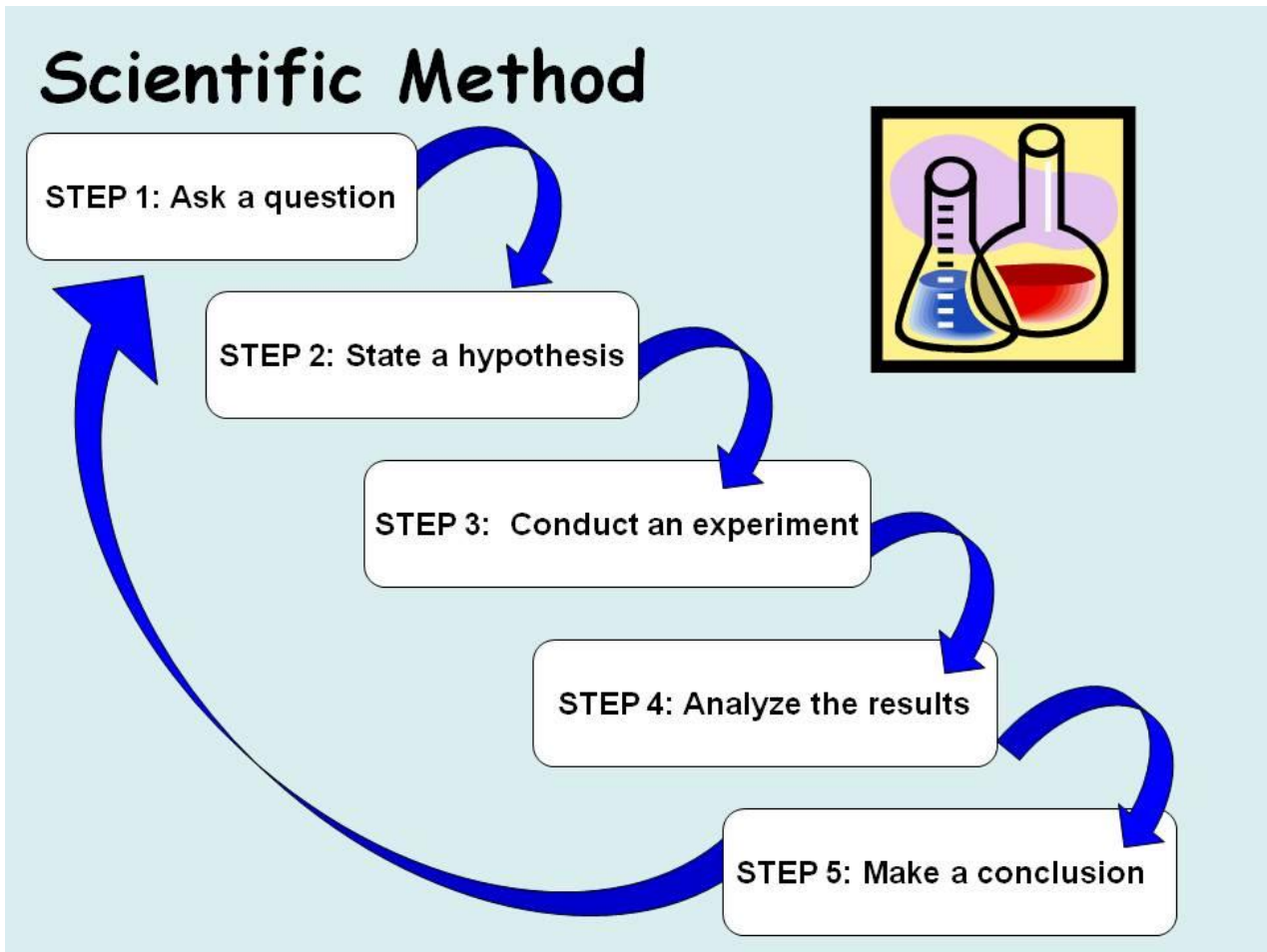


Fig.6 - Fundamentals of the scientific method

The concept of recurrent actions

That is steps of rigid algorithm. The next steps use the previous results.

A recurrence relation is a formula that allows you to calculate the next terms of a numerical sequence based on the values of the previous terms. A recurrence relation uniquely defines a sequence if the first terms of the sequence are specified. A recursive relation is an example of a recursive sequence definition.

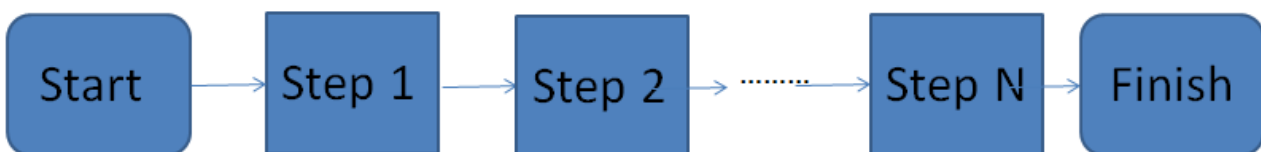


Fig.7 - recurrent actions

Each result in science - an occasion to improve it

The Scientific Method as an Ongoing Process

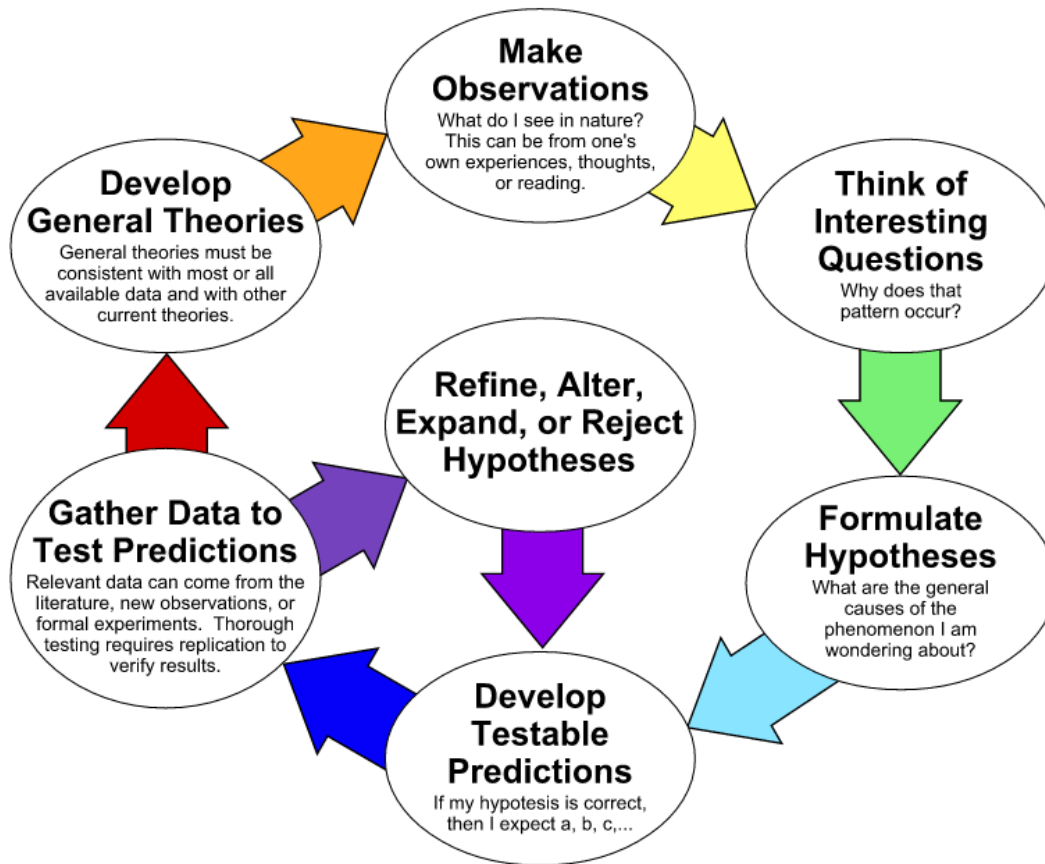


Fig.8 – Ongoing process

The notion of iteration actions

That is repeating the action at a higher level.

Iteration is a process where a set of instructions or structures is repeated in sequence a certain number of times or until a condition is met. When the first set of instructions is executed again, it is called an iteration. When a sequence of instructions is executed repeatedly, it is called a loop.

Iteration is the repetition of a process in order to obtain a result. The sequence will approach some end point or end value. Each repetition of the process is one iteration, and the result of each iteration is the starting point of the next iteration.

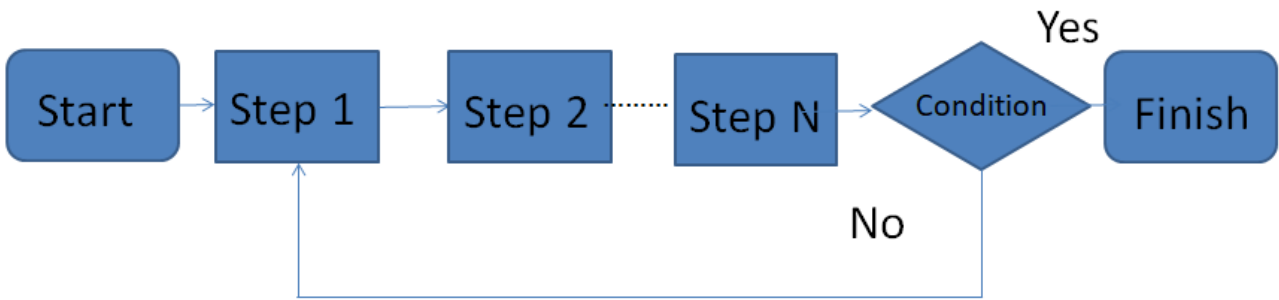


Fig.9 - Iteration actions

The experiment during lecture

1. The problem is to evaluate the quality of the salami
2. Hypothesis - our audience is competent enough for this
3. Experiment - try salami
4. Handle experiment
5. For clarification experiment (iteration)
6. Handle second experiment
7. Concludes

Table 4

Fill in the table in your notebook and on a separate sheet of paper

Number of expert	Self-rating (S)	Rating (R)	Comments
1			Tasty!
2			it smells of soy=(
3			a lot of fat
4			...
5		
6		

The experiment results

- All written evaluations, which I declare
- 1. Self rating.....S1=, S2=
- 2. Rating....R1=, R2=

Let's count

- Middle self-rating = $(S1 + S2 + \dots + SN) / N =$ - this is our qualification group for the evaluation of sausage (N – number of students)
- A simple Rating= $(R1 + R2 + \dots + RN) / N =$ -
- The average Rating= $(S1 * R1 + S2 * R2 + \dots + SN * RN) / (S1 + S2 + \dots + SN) =$
- The maximum rating
- The minimum rating
- Quartile is the sum of maximum and minimum divided by 4
- Confidence Interval - The lower boundary of the confidence interval will be (at least + quartile), the upper (maximum - quartile).

These are the elements of the statistical method and Delphi method, we consider it more later.

Task 3

Calculate middle self-rating, a simple rating, the average rating from experiment in classroom.

The first phase of research - the study of the state of matter

Open any book or academic journal.

You will definitely see the letters and numbers (in Ukrainian writing УДК) on the first page. This is a universal decimal code. It defines the branch of knowledge, which is the subject of this paper.

Find a branch of knowledge that you are interested, write code UDC.

Another innovation of recent years - an individual number ORCID

ORCID (Open Researcher and Contributor ID) - single international register of scientists. ORCID - is essentially part of the ranking scientist.

Task 4

- *Write code УДК of branch of knowledge that you are interested*
- *Register your own ORCID number.*

3. Investigation of the state of the question

Scientific research begins with an information search. Then they move on to scientific research. There is a dialectical relationship between information and scientific research, since scientific research begins with the formulation of a hypothesis that is tested by experiment.

The organization of scientific research involves studying the state of the research object, specifying the place of the scientific topic in scientific research; definition of the research object. At this stage, a preliminary determination of the theoretical base takes place (theoretical foundations that are the basis for scientific research, consideration of history, assessment of the current state of the problem, collection of information about the object, proposal and substantiation of hypotheses). Organizational and methodical preparation of scientific research involves 19 drafting: scientific research program, technical and economic justification (representation of the most important indicators of scientific work), topic research plan, research methodology (list of methods and techniques that will be used in scientific research, putting forward hypotheses and their generalization), work plan.

The first step in any research is to investigate sources. So, we must to know what is fulfilled in our field of science to our time.

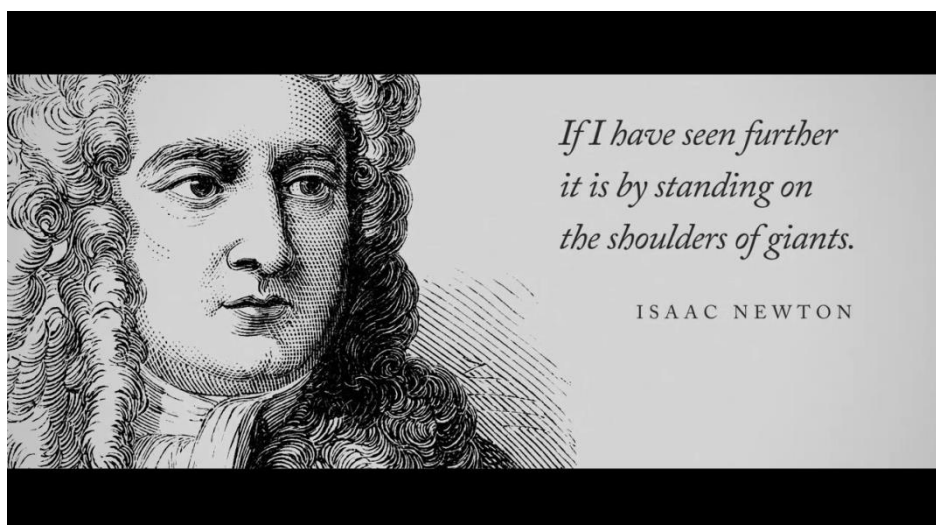


Fig.10 – Isaac Newton

State of research questions

SOURCES:

- Books
- Articles in journals
- conference Proceedings
- Legislative and regulatory documents
- Electronic resources

Making bibliography

Books

One author

Centellas M. Research Methods Handbook. Oxford: - University of Mississippi. – 2016. -90 p.

Two authors or more

Stephe N.S. Beginner's Guide to Scientific Method./ Stephe N.S., Carey A. – Wadsworth: -Cengage Learning.-2004.-143 p.

More than four authors

Make: 3D Printing Projects./ [Drumm B., Kelly J.F., Roe B. and others]. – San Francisco: - Maker Media Inc. - 2015. – 283 p.

Articles in scientific journals

Riabchykov M., Alexandrov A. Magnetic nanotechnology in the production of foamed textile materials for medical purposes.//Fibres and textiles. -2021.-Vol.28.-No3.- p.66-72

Legislative and regulatory documents

Кримінально-процесуальний кодекс України : станом на 1 груд. 2005 р. / Верховна Рада України. – Офіц. вид. – Київ : Парлам. вид-во, 2006. – 207 с.

Electronic resources

Blakstad O. Scientific Method. How Knowledge is Made. [Electronic resource] Retrieved (Dec 6, 2012). - Access mode Sep 18, 2022 from Explorable.com: <https://explorable.com/scientific-method>

Task 5

According to the chosen topic of research find a book, a scientific article, an electronic resource

International bibliographic database

- Web of Science, Scopus, Index Copernicus, Astrophysics, PubMed, Mathematics, Chemical Abstracts, Springer, Agris, GeoRef

ORCID

- ORCID (Open Researcher and Contributor ID) - single international register of scientists. ORCID - is essentially part of the ranking scientist.

Task 6

Sign in ORCID. Bring your personal number

4.The main features of the dialectical theory of knowledge

Dialectics is the the science of the general laws of motion and development of nature, human society and thought

Usually there are three rules of dialectics

- The law of unity and struggle of opposites
- The law of transition of quantitative changes into qualitative
- The law of negation of negation

Questions that meet these laws

1. development Source



Fig.11 – Where is development Source (drawing by Jean Effel)

Unity and struggle of opposites

- The movement and development in nature, society and thinking due to bifurcation single on interpenetrating opposites and resolve contradictions between them.

The law of unity and struggle of opposites indicates the source of movement, development of objects, processes and phenomena. According to him, the most important condition that generates development is dialectical contradiction. Based on its universal nature, all objects, processes, and phenomena are contradictory (identical and not identical to themselves). This means that they consist of one or more pairs of opposites, polar principles (plus and minus, attraction and repulsion, assimilation and dissimilation, warring sides in war, humane and inhumane, beautiful and ugly, truth and delusion, etc.). They are not only mutually exclusive, but also presuppose, mutually condition each other, Hegel once emphasized that anything in the world is viable only when it is able to contain contradictions and withstand them.

They cover all spheres of existence (nature, society, spiritual sphere), although they manifest specifically in each of them. We are constantly faced with them, but fixing them at the level of everyday consciousness does not allow us to understand the essence of the dialectical contradiction. So, opposites are the main tendencies, aspects, properties of objects, processes, phenomena (systems). their ratios may be different (depending on their severity, etc.).

Depending on the functioning of different forms of matter, the manifestation of contradictions is different. Among them, internal and external ones are distinguished. The first ones include those that arise between two opposites within the limits of a certain subject, process, phenomenon (assimilation - dissimilation, etc.). The second type includes contradictions that arise between two objects, processes, phenomena (the relationship between society and nature, etc.). Internal ones act as a source of development, external ones as peculiar conditions for the existence of this subject.



Fig.12 – Unity and struggle of opposites

Actuality, as a result of the struggle of opposites can be shown on fig.12

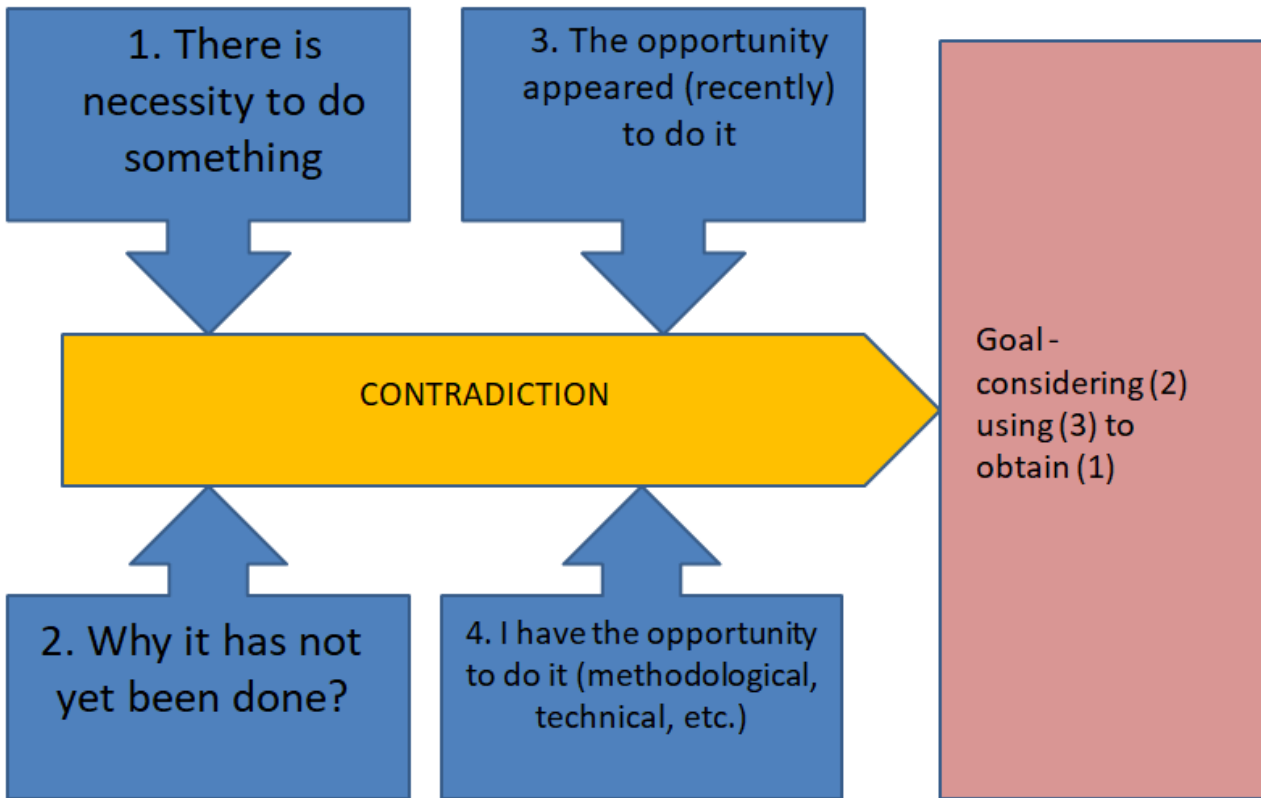


Fig.13 - Actuality, as a result of the struggle of opposites

Task 6

Write a contradiction, causing the need to conduct your research

5.Character of development

Transition from quantity to quality can be formulated in such form:

The development is carried out by the accumulation of quantitative changes in the subject matter, which inevitably leads to a violation of its measures (steady state) and the abrupt transformation into a new object.

The main laws of world development reveal the mechanism, cause and direction of changes taking place in it. Thus, the law of mutual transition of quantitative changes into qualitative ones characterizes one of the sides of this movement, one of the facets of universal development. He reveals the mechanism of development,

explains how development occurs, thanks to which processes and how objects undergo qualitative changes and transformations.

To understand the essence of this law, it is necessary to define the categories "quality", "quantity", "measure".

Quality. It is necessary to distinguish the concept of "quality" in everyday and philosophical sense. In everyday life, the word "quality" reflects the degree of value of a thing, its positive or negative evaluation from the point of view of satisfying one or another human need. The word "quality" has a completely different meaning in philosophy. In everyday life, we come across a wide variety of phenomena, processes, and objects. At the same time, many of them have nothing to do with human needs. But we still distinguish some objects and phenomena from others (plant and animal, water and acid, sand and clay...). This is explained by the fact that each subject has its own qualitative determination, which distinguishes it from other subjects. That which is characteristic of a certain thing, which distinguishes it from another, is what we call quality in philosophy. Bodies of both animate and inanimate nature, as well as all phenomena of social life, are characterized by qualitative determination. Quality is the internal determination of objects and phenomena, a set of their essential features, sides, which makes them certain objects and phenomena.

Property. The sense organs give us the initial indicators about the qualitative differences of objects and phenomena. The surrounding reality acting on the sense organs causes us certain sensations (heat, cold, color...). These sensations enable us to judge the quality of things. But sensations provide knowledge only about individual aspects or signs of things, not knowledge as a whole. The senses are not capable of distinguishing the essential from the inessential. And in order to determine the quality, it is necessary to highlight the root, essential signs or properties. It gives thinking. So, knowledge of quality begins with knowledge of properties. A property is any feature by which one object or phenomenon differs from others or is similar to them. Quality is manifested through a property, and we can know the quality of a particular object or phenomenon only by properties, what this quality manifests. Each property of a thing manifests itself only in interaction with other things.

Number. The quality of objects and phenomena does not exist apart from their quantitative characteristics. This is also a very important aspect of objects and phenomena. Quantity is an external characteristic of objects and phenomena that characterizes them in terms of the degree of development of properties: volume, number, speed of movement, etc. Quantity has its own characteristics compared to quality. First, change amount within certain limits does not cause significant changes in things and phenomena. Limits of quantity are more mobile, elastic than limits of quality. After all, when an object loses its quality, it ceases to be what it was. This does not happen with regard to quantity. Secondly, the content of the subject, its quality, is of no importance for characterizing the subject from the quantitative side. We are not interested in the material of the object. Calling the number five, we are not interested in whether it means the number of fingers on a hand or the petals of a flower.

Quantity and quality exist objectively. In objects and phenomena, they are in an inseparable unity. We can only consider them separately in our minds. The concept of quality allows us to capture the moment of permanence in things. The concept of quantity makes it possible to reflect the variability of things.

Measure. The relationship between quantity and quality is expressed in the concept of "measure". The unity of quantity and quality is called measure. Everything should be within certain quantitative limits. Heat is necessary for the growth of plants, but heat destroys them. The same with moisture. You can give the following definition of a measure. A measure is the limit of change in quantity, within which an object retains its qualitative determination. Measure is the limit of the existence of objects. The unity of quantity and quality is preserved only within the limits of measure. If quantitative changes are made within these limits, they do not cause qualitative changes. If they go beyond measure, they are accompanied by qualitative changes in objects and phenomena.

A jump is the very process of transition from one quantitative composition to another, the replacement of an old quality with a new one. It represents a dialectical unity of discontinuity and continuity.

The abrupt accumulation of changes, a sharp change in the quality can be seen on the series of examples (fig.14-16)



Fig 14 - The transformation of water into ice



Fig.15. - The transformation of the projectile in the spacecraft

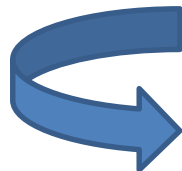


Fig.16 - The transformation of student into a specialist

Types of qualitative transitions in a functional form are shown on fig.17.

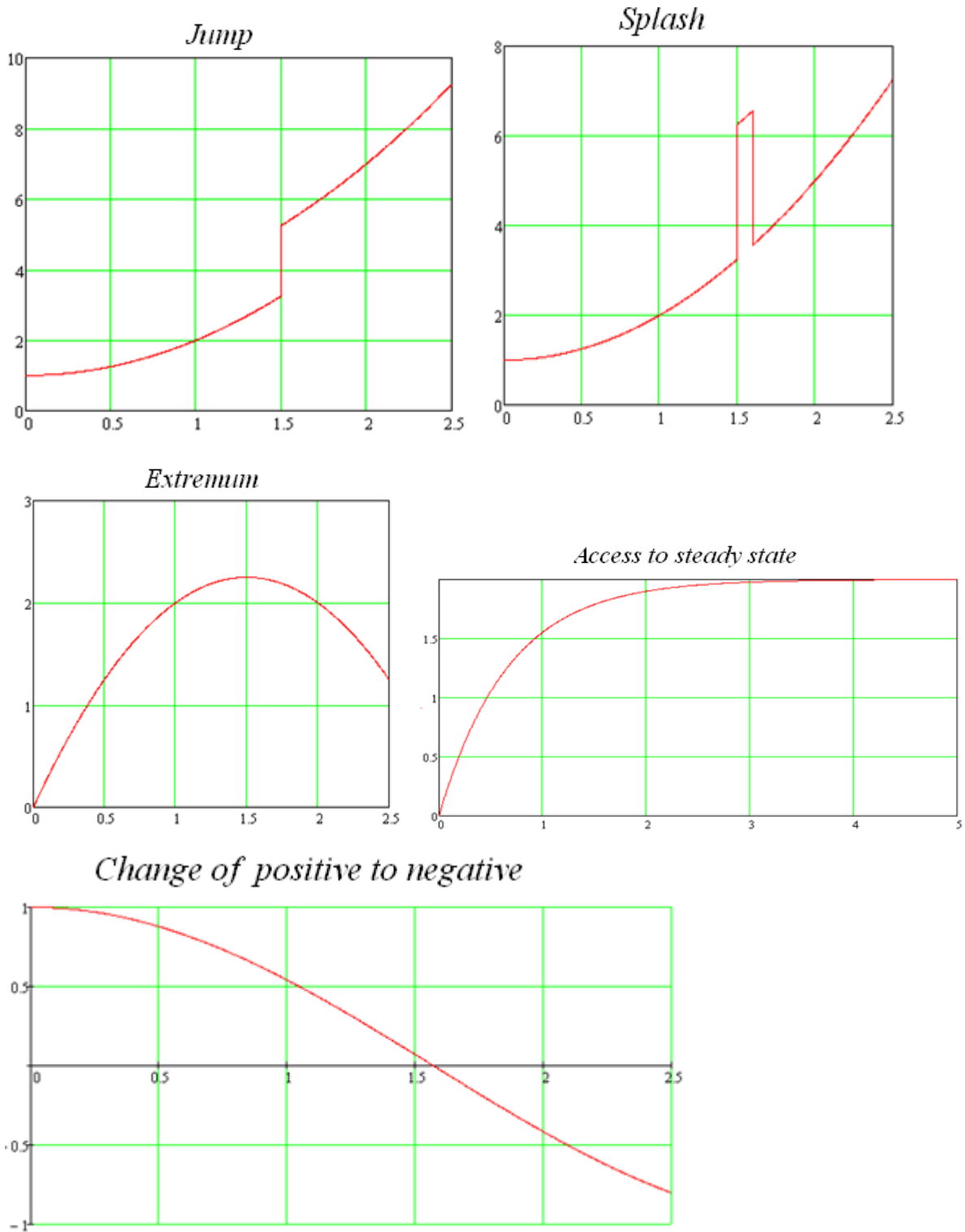


Fig.17 - Types of qualitative transitions in a functional form

Task 7

Give five examples of the transition of quantity into quality

6. The meaning of development

The law of negation of negation reflects the repetition at a higher level (fig.18)

Negation of the negation can be formulated in such way.

Development goes through constant negation of opposites of each other, their mutual transformation, resulting in the progressive movement is returned back to the new features of the old repeated.

All phenomena of nature and society develop through negation. But objections can be understood in different ways. Dialectical interpretation is fundamentally different from metaphysical. For metaphysics, to deny means to eliminate, reject, destroy without a residue, without retaining the positive. There is no idea about the development process. This can have a harmful effect on social life. In particular, a complete metaphysical denial, "rejection" of the achievements of the previous culture and the creation of "new art" in an empty place negatively affects the development of world culture in general.

There is no complete overcoming in nature and there cannot be, because matter itself is indestructible, does not turn into complete non-existence.

Thus, denial can appear in the form of destruction, death of a certain phenomenon and in the form of its transition from a lower stage of development to a higher one. From the point of view of development, of course, such a denial is important, which preserves the possibility of progressive development of a certain phenomenon.

Dialectical negation is characterized by the following features:

- denial is the overcoming of the old, which has outlived itself, hinders development;
- negation is the preservation of everything positive that can develop.

Dialectics considers negation not as an act of intervention by an external force, but as self-negation, that is, the transition of a phenomenon into its opposite, where the negated and that which negates are sides of a single contradiction.

Objection from the point of view of dialectics is both absolute and relative. Absolute in the sense that any development is carried out in the form of negation. Relative because it involves not a complete negation, not an absolute destruction, but the preservation of certain aspects that are necessary for further progressive development.

The process of development in the objective world never stops. Each negation gives rise to a new negation that is intrinsically linked to the first. The change of one negation to another is expressed by the concept of negation of negation.

The negation of the negation is the law of continuous development, that is, each phenomenon is the result of the negation of the previous phenomenon. The new, which develops and becomes old, is denied by the new and so on ad infinitum.

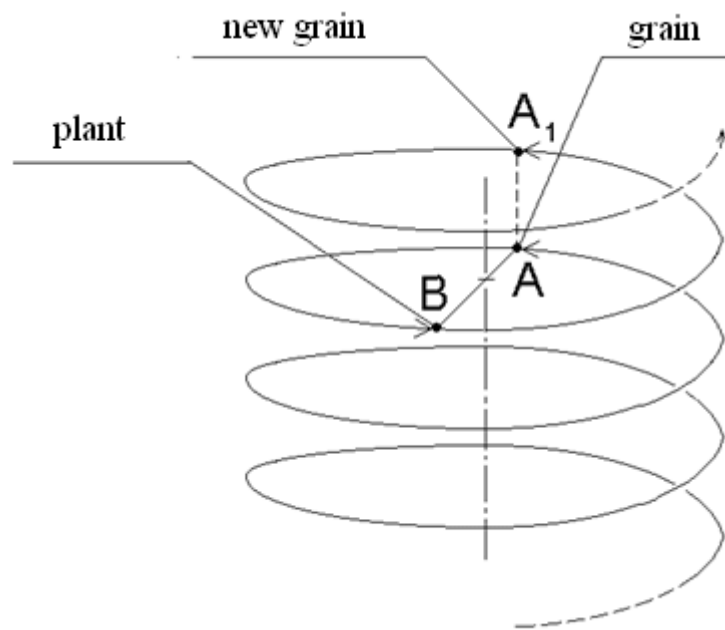




Fig.18 - Repetition at a higher level on example of grain

Task 8

Give an example of negation of negation from the field of fashion industry.

7.The object and subject of study

For the successful implementation of a scientific or other creative work, it is desirable to highlight the main provisions before starting it. It is customary to consider the subject and object of research to be such bases.

Object is a broad concept. It can include multiple properties or concepts. Usually, the object of research is a subject, process or phenomenon that exists independently of the researcher. The object is closely related to the research topic, but does not duplicate it.

The subject of research usually defines some part or certain properties of the object. When determining the subject of research within the object, one should answer the question "what will be researched"? The answer to this question specifies phenomena or relationships within the object.

The object and subject of study can be formulated on the base of Search of research subjects (fig.19-26) such as cause and effect, necessity and chance, content

and form, whole and part, element and structure, the essence and the phenomenon, possibility and reality. Separately, let's highlight the concept of fluctuation - the deviation of some value from its average value.

During defining objects and subjects of research, it is rational to use the main categories of scientific knowledge.

The reason is a system of connections and relations that causes changes, emergence, destruction of objects, phenomena, connections. Often, during talking about the cause, it is identified with an object, phenomenon, connection that preceded the appearance of a new object, phenomenon, connection. But this should not be done. The reason is not the subject, but the system of connections that causes the emergence of something new. Without knowing this conditioning, our consciousness sees a causal relationship precisely in the immediate time sequence of events. A cat ran across the road, a woman met with an empty bucket - it is believed that this is the reason for the next failure. The cause exists in an inextricable connection with the effect.

An effect is the result of a cause. The effect always includes a new meaning, which was not in the cause. The cause does not exist before the effect. To the consequence there are connections and relations in which the possibility of a certain consequence arises. But they are not yet a reason, but only a condition. A condition turns into a cause only when a consequence appears.



Fig.19 – Cause and effect

An important role in revealing the features of general connections and relations is played by the interrelationship of necessity and chance.

Necessity is a system of connections and relations that causes change, progressive movement, development in a rigidly defined direction with rigidly defined results. In other words, necessity is such a connection that necessarily leads to a certain event. A bullet fired from a rifle will necessarily fall somewhere on the ground, because the force of the charge, the initial velocity of the bullet, cannot overcome the force of gravity. The movement of river water is also determined by the force of Earth's gravity.

Contingency is a system of connections and relationships in which the occurrence of a certain event may or may not occur. It can also be said that randomness is such a connection in which the occurrence of an event does not follow general trends of development, it cannot be predicted. With many alternative possibilities and many reasons, with changing circumstances, any possibility can be realized.

Necessity and chance are closely interrelated. One of the most important features of their relationship is that randomness is a form of manifestation of necessity. The necessity is revealed only through many coincidences. During a thunderstorm, lightning strikes certain objects on the surface of the earth. Lightning itself is a necessary result of the difference in electrical potential between the clouds and the ground. But exactly where the lightning strikes: in a tree, in a house, in some other object is a coincidence. This hit may or may not have happened if, for example, the wind that rose before it drove the cloud to another place.

Chance is often seen as the intersection of two necessities. Two planes collided in the air. Each of them, given the speed and direction of the flight, had to necessarily pass through the meeting point. But this could not have happened if the pilots had noticed each other in time and changed course.

All randomness is determined by reasons. For example, the same collision of planes could be due to insufficient attention of pilots or incorrect information from the control room, bad weather conditions, poor visibility.

The definition of the ratio of necessity and chance depends on the more general system of connections in which they are considered. What appeared to be necessary in one condition, in one respect, may appear as accidental in other conditions, in another respect.

The relationship of cause and effect, possibility and reality, necessity and chance express the inseparability of the development process. These are only different sides, aspects of this process. In any development process, cause and effect, possibility and reality, necessity and chance are present at the same time. They complement each other. their selection and consideration of each one separately is a condition for a person's deeper knowledge of the surrounding world and himself.

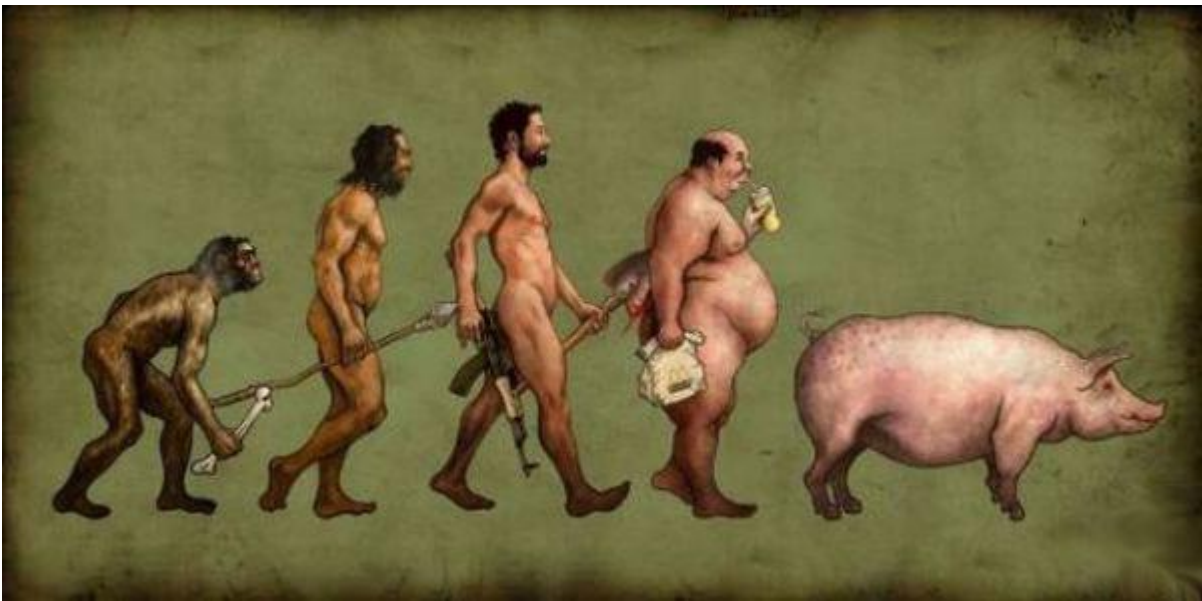


Fig.20 – Necessity and chance

One of the most important examples of randomness for science is fluctuation. Fluctuation is a random deviation of the value of a physical quantity from the average in a certain area of space or at a certain moment in time.

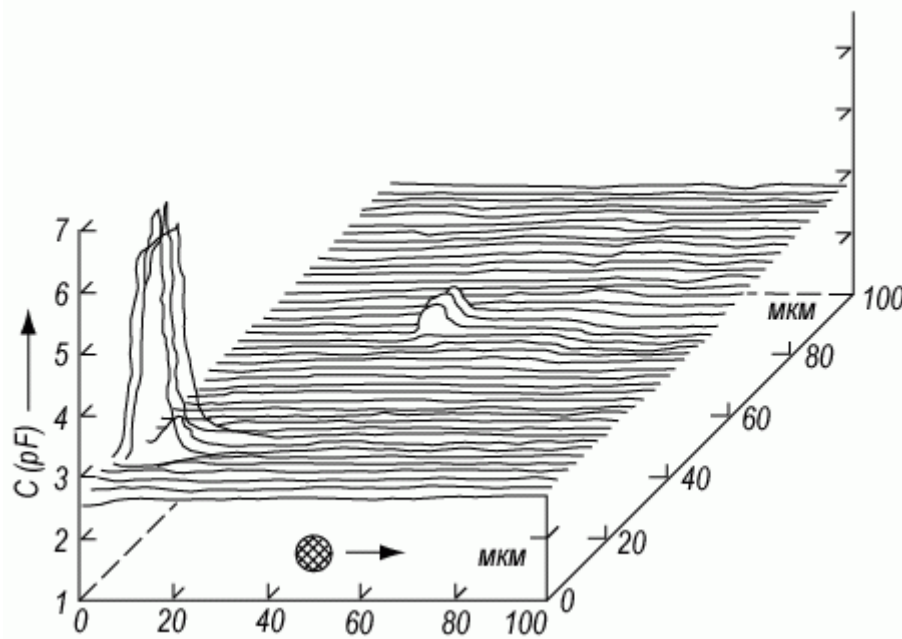


Fig.21 - Fluctuation

Content is a set of elements, processes, connections that make up this subject or phenomenon. This definition is almost identical to the concept of "essence" and is closely related to it. However, the essence is more abstract, broader than the category "content". It defines the main, decisive, deeper internal connection of the objects that form its basis. The concept of "content" is somewhat narrower. It also reflects an internal and decisive connection. However, not in its most general form, but in the form that is implemented in each individual subject (group of subjects) at a certain stage of development, under certain conditions. For example, the essence of life in its most general form is the process of material exchange in the protein body. The specific manifestation of this connection in any cell or organism will be different. In this case, the content is a manifestation of the essence in this specificity, an internal connection in a separate one.

The form is the expression of the content, its conditioning. This is the internal and external organization of the content, the way of its existence, which has a certain certainty, stability and independence.

The form is inextricably linked with the content, and through it - with the essence.

The provision on the primacy of content in relation to form is of great importance for science and practical activity. However, the form is not something indifferent, passive in relation to the content. It is worth recalling the role of industrial relations in the development of society, public awareness of the basis, improvement of organizational forms of social activity, etc.

Therefore, content and form are integral aspects of things, processes, phenomena of the objective world. At the same time, the content plays a decisive, leading role in relation to the form. The form itself has certain independence and affects the development of the content. Any content can be manifested in various forms.



Fig.22 - Content and form

It has always been believed that in order to know and understand this or that subject, one should know what it consists of. To implement this, the concepts of "simple-complex", "part of the whole" were used in philosophy. For a long time, the simple was considered elementary, i.e., the one in which there are no parts, and the complex - the one that can be decomposed into parts. Those objects from which more complex objects could be formed were called parts. In turn, the whole was understood as a combination of parts, that is, their simple sum.

At a certain historical stage, it was established that the whole is something other than the sum of its parts. That is, a set of details of any object is not the object itself. The difficulty of solving the riddle of integrity often led to its mystical interpretation.

Over time, the belief that the properties of the whole cannot be reduced to the set of properties of its parts was increasingly established. But on the basis of metaphysical thinking, it was not possible to detect this. With the help of dialectics, it was established that the secret of integrity lies in the connections that unite objects into complex complexes, in the interaction of their parts. This was the discovery of the principle of integrity, which is of great importance in human cognition of the world.

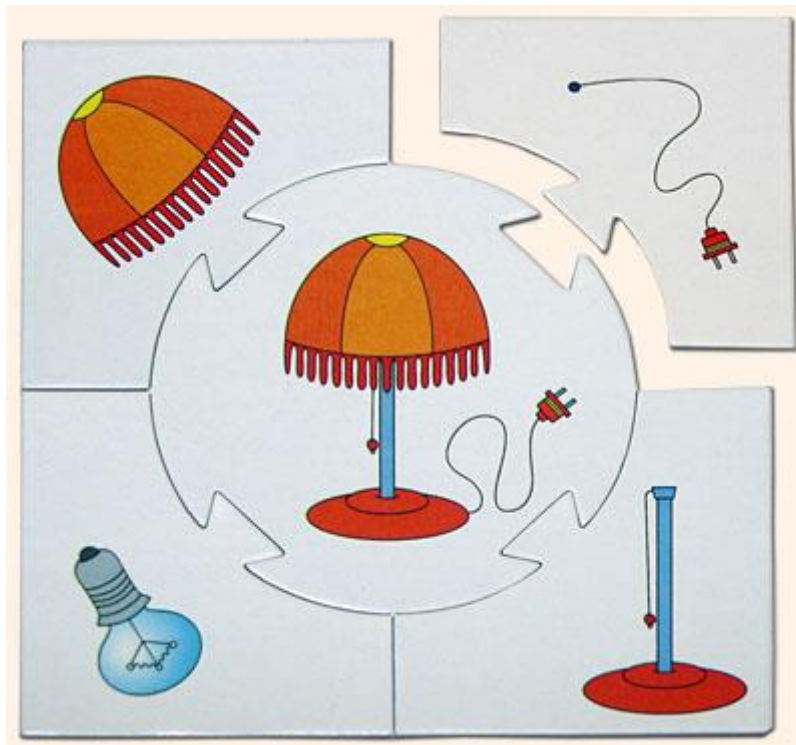


Fig.23 – Whole and part

The addition and development of the categories of the whole and the part are the categories system, structure, element. In the modern sense, the system is defined as an organic set of elements that are in regular relationships and connections, forming a certain integrity.

An element is a category in which an indivisible particle of a thing is further conceived. Thus, matter is made up of atoms, and atoms are the elements of matter.

But we know that the atom is divisible. Why do we not consider elementary particles to be the elements of matter? Because elementary particles are elements of various fields, but not substances.

Structure - the structure and internal organization of the system, the unity of stable relationships between elements. The concepts of system and element are close to the categories of part and whole. However, these are not identical concepts. Thus, a part is divisible, an element is a further indecomposable component of the system in the given way of considering it. The system can also be compared with the whole and, like the whole, is characterized by the connection of parts, their orderliness and organization.

However, when studying the whole, the task of establishing its specificity, qualitative certainty, comes to the fore. The systems approach is focused on establishing general principles and laws of behavior of systems, regardless of their qualitative originality. That is why the concept of a system has an extremely wide scope. Nevertheless, a systematic consideration of any object is not always productive. No household appliance (spoon or teapot, student notebook, etc.) needs to be systematically considered.

Периоды	I	II	III	IV	V	VI	VII	VIII	VIII	
1	H 1,0079							He 4,0026		
2	Li 6,94	Be 9,012	B 10,811	C 12,011	N 14,0067	O 15,999	F 18,998	Ne 20,179		
3	Na 22,989	Mg 24,305	Al 26,981	Si 28,086	P 30,973	S 32,06	Cl 35,453	Ar 39,948		
4	K 39,098	Ca 40,08	Sc 44,956	Ti 47,90	V 50,942	Cr 51,996	Mn 54,938	Fe 55,847	Co 58,933	Ni 58,70
5	Rb 85,47	Sr 87,62	Y 88,906	Zr 91,22	Nb 92,906	Mo 95,94	Tc 98,91	Ru 101,07	Rh 102,905	Pd 106,4
6	Cs 132,905	Ba 137,33	La 138,91	Hf 178,49	Ta 180,948	W 183,85	Re 186,21	Os 190,2	Ir 192,2	Pt 195,09
7	Fr [223]	Ra 226,025	Ac [227]	Ku [264]	Ns [269]	Po [209]	At [210]	Rn [222]		
8	Ce 140,90	Nd 144,24	Pm [145]	Sm 150,36	Eu 151,96	Gd 157,25	Tb 158,925	Dy 162,50	Ho 164,93	Er 167,26
9	Th 232,038	Pa 231	U 238,03	Np [237]	Pu [244]	Am [243]	Cm [247]	Bk [247]	Cf [251]	ES [254]
10	Lu 174,967	Yb 173,04	Tm 168,93	Er 167,26	Ho 164,93	Gd 157,25	Tb 158,925	Dy 162,50	Ho 164,93	Er 167,26
11	Lr [260]	Lr [260]	Lr [260]	Lr [260]	Lr [260]	Lr [260]	Lr [260]	Lr [260]	Lr [260]	Lr [260]

Fig.24 – Element and structure

If the categories of content and form characterize the subject as a whole that has its own structure and way of expression, then the categories of essence and phenomenon characterize the interrelationship of the internal and external, the connection of what is hidden in the depth of processes with what appears on the surface . Essence is the internal connections and relationships that determine the quality of a specific object; phenomenon - the external form in which the essence of this object appears. The essence and the phenomenon are related to each other as universal and singular, because the essence is expressed not in one phenomenon, but in a multitude of them, each of which acts as a single entity in relation to the essence. Exploitation of hired labor is the essence of capitalism; unemployment, uncertainty about the future, crises, etc. - manifestations of this essence.

The essence by its nature is identical to the law, the law and the essence are homogeneous concepts, of the same order, or rather, of the same degree, which express the deepening of human knowledge of phenomena. Like the law, the essence expresses the internal, essential and stable connections that determine this or that process. However, the essence is broader and a general connection than the law, so the same essence is expressed by many laws. Thus, the essence of capitalism is expressed both in the law of surplus value and in the law of competition, etc. Without revealing the essence and laws of development of these or other objects, our knowledge of the world would not go beyond external observations and fixation of phenomena, but this would not be scientific knowledge of reality, because scientific knowledge of the world requires knowledge of laws, the essence of phenomena. Knowing the essence and laws is not easy, because they are hidden, they are not on the surface of events and processes.

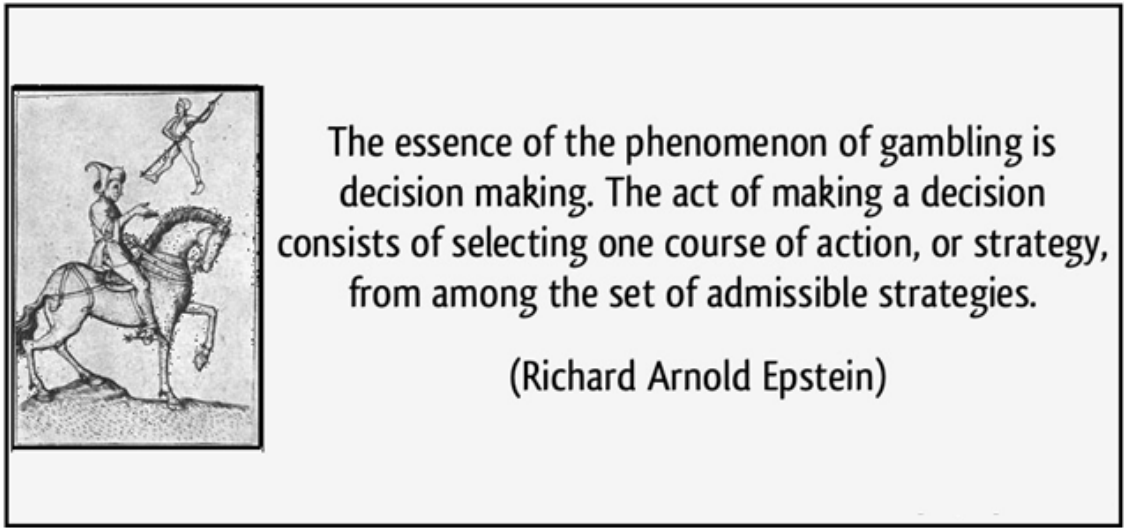


Fig.25 – The essence and the phenomenon (drawing from izquotes.com)

The cause-and-effect connection does not exhaust all the wealth of connections and relations. It is not the only all-determining connection. Not all conditions turn into a cause. Conditions create prerequisites under which movement, change can be carried out in different directions, generate different results, that is, it contains an opportunity.

An opportunity is a system of connections and relationships that cause the emergence of trends, prerequisites for changes, development in a certain direction, with certain predictable results. This is the future in the present, which under a certain coincidence of circumstances can become a real fact.

Reality is a realized possibility, prerequisites, embodied in actually existing objects, processes, connections in their qualitative certainty. The fact that the possibility appears as a prerequisite, a potentiality, in reality turns out to be an existing existence. A possibility is formed into reality, its transformation into reality is characterized by the emergence of new possibilities.

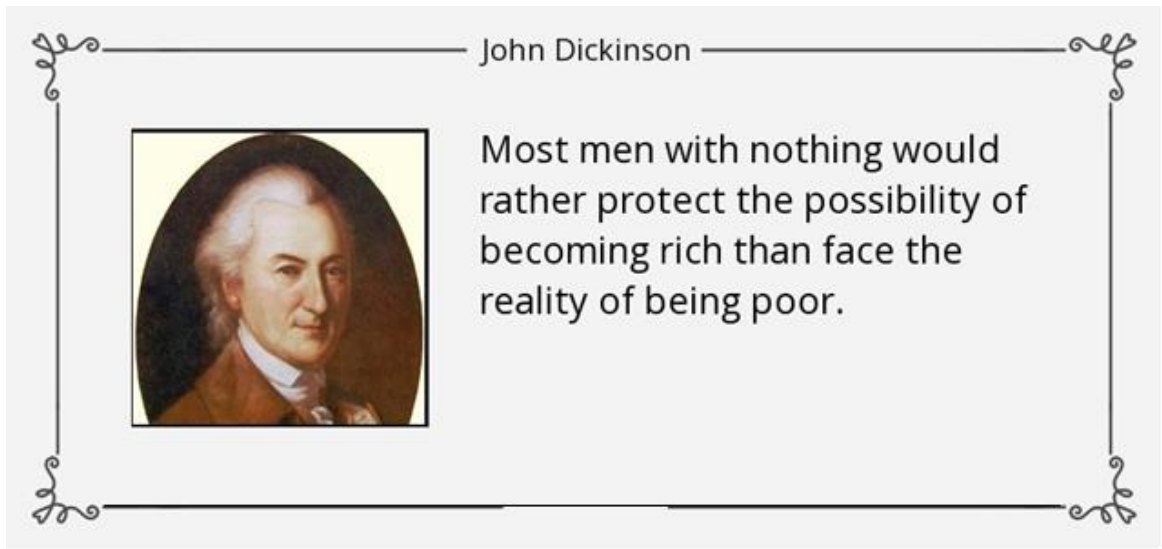


Fig.26 – Possibility and reality (drawing from izquotes.com)

Task 9

Identify the object and the subject of your research

8. Basic research methods

Axiomatic method is a procedure by which an entire system (e.g., a science) is generated in accordance with specified rules by logical deduction from certain basic propositions (**axioms** or postulates), which in turn are constructed from a few terms taken as primitive.

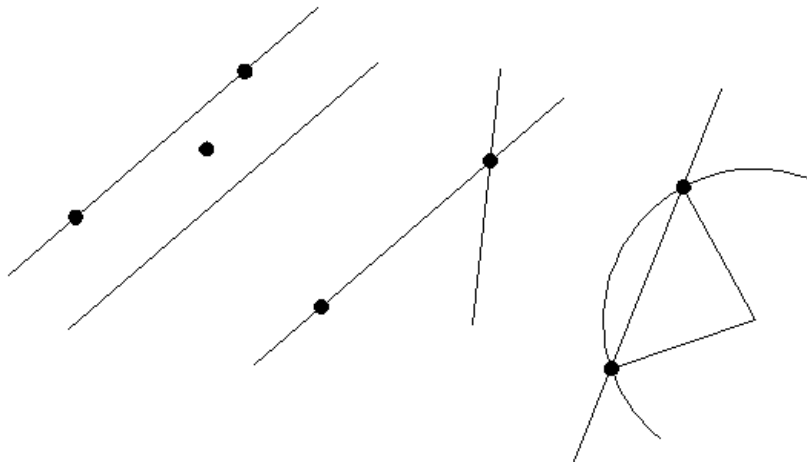


Fig.27 - Axiomatic method in geometry

The hypothetic-deductive model or method is a proposed description of scientific method. According to it, scientific inquiry proceeds by formulating a hypothesis in a form that can be falsifiable, using a test on observable data where the outcome is not yet known. A test outcome that could have and does run contrary to predictions of the hypothesis is taken as a falsification of the hypothesis. A test outcome that could have, but does not run contrary to the hypothesis corroborates the theory. It is then proposed to compare the explanatory value of competing hypotheses by testing how stringently they are corroborated by their predictions.



Fig.28 - The hypothetico-deductive method

Traditionally, theoretical and experimental studies are distinguished in science. Theoretical research –use of mathematics / logic reasoning to prove what you are saying is definitely true.

Empirical research that is research through observation – run many experiments to show that what you are saying is probably true.

The historical and logical methods can be distinguished within theoretical studies. Within the framework of the historical method, the behavior of the object of research is reproduced within a certain time, taking into account individual subjects of influence, randomness, fluctuations, etc. This method can be used both in the study of human history and for the phenomena of living and non-living nature. Its use allows obtaining an idea of the empirical data of the object's history.

The logical method determines certain conditions as a result of which certain phenomena and results were realized. It allows you to reproduce regular connections and relationships.

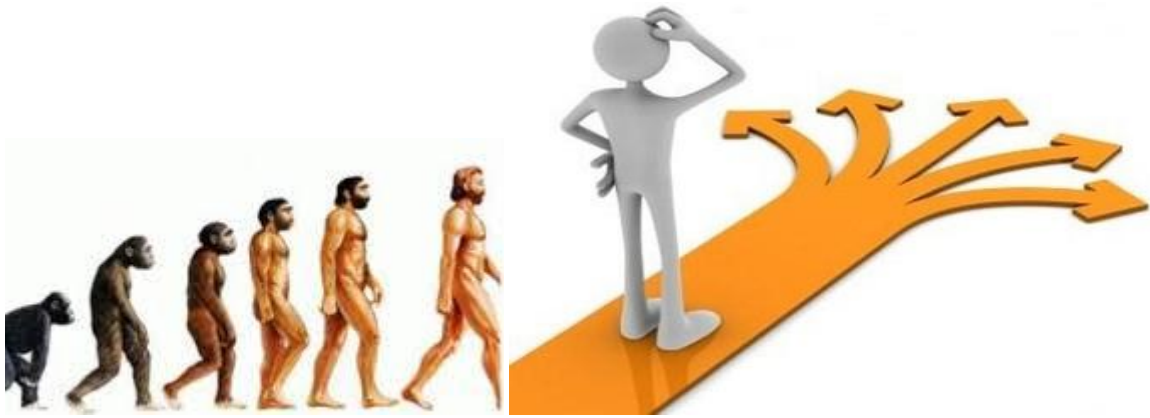


Fig.29 - The historical and logical methods

Logical actions are used for implementation of theoretical research.

Law of identity

In the process of reasoning, every meaningful expression (concept, judgment) must be used in the same sense.

In formal logic, the law of identity is usually expressed by the formula: A is A, or $A = A$, where A is any thought.



Fig.30 – Paralogism

Paralogism - the law of identity is involuntarily violated, out of ignorance, then logical errors arise, which are called;

- Sophism - when this law is violated deliberately, in order to confuse the interlocutor and prove him some false thought, then errors appear, called.

“What you have not lost, you have; you did not lose the horns; so you have horns.” Sophism attributed to Evbulid

Evbulid's wife as if hint



Fig.31 – Sophism of Evbulid

Amphibolia is a logical error based on the ambiguity of language expressions. Another name for this error is “the substitution of the thesis.”

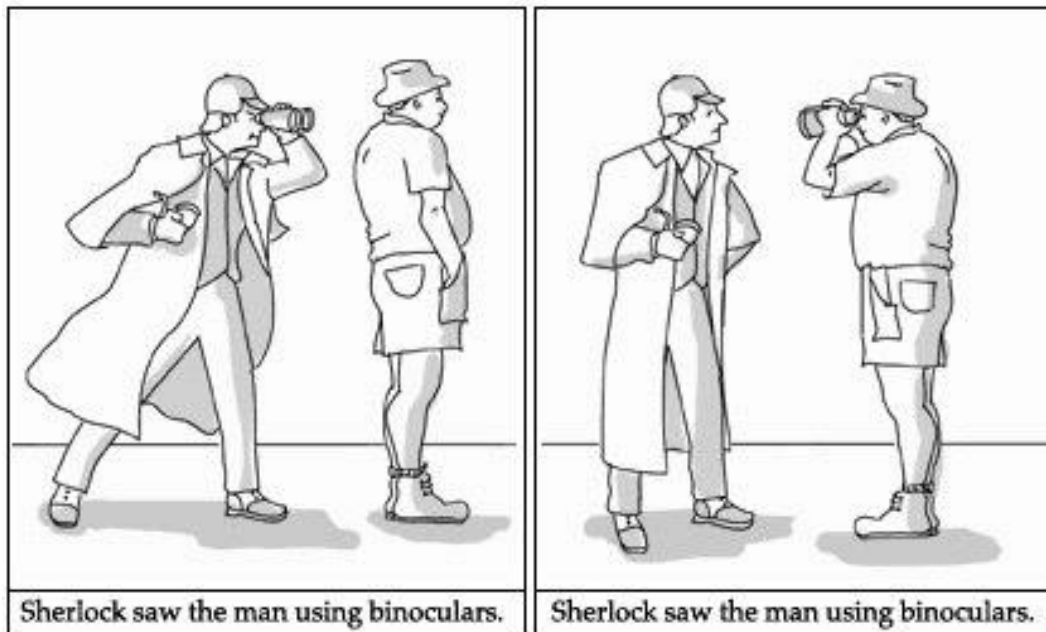


Fig.32 – Amphibolia

The law of the excluded middle

- of two statements - “A” or “not A” - one is necessarily true, that is, two judgments, one of which formulates the negation of the other, cannot be simultaneously false.

- $A \vee \neg A = 1$



Fig.33 – The excluded middle

Law of Contradiction

Two contradictory judgments cannot be true at the same time. At least one of them is false.

- $A \wedge \neg A = 0$

This law will be valid only when the speaker's judgments talk only about one subject, considered at the same time.

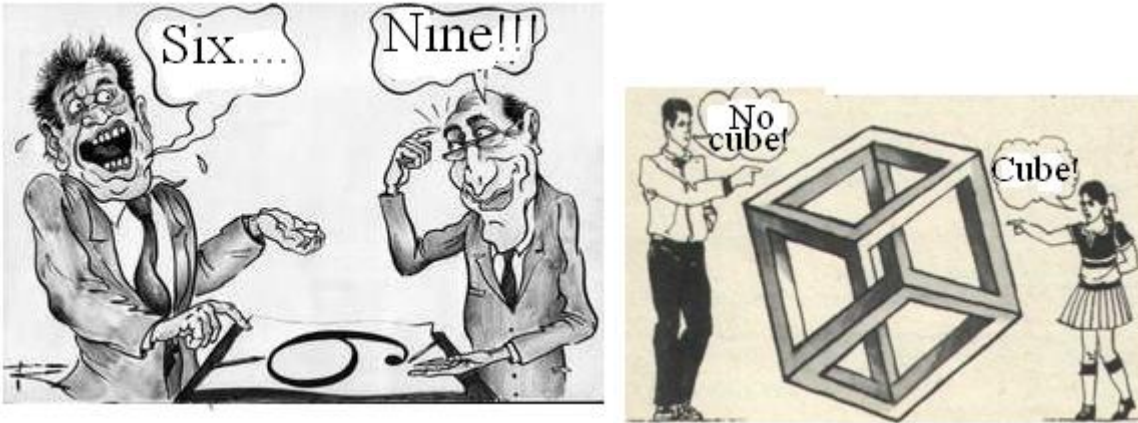


Fig.34 – Contradiction

Law of reason

every meaningful expression can be considered reliable if sufficient grounds were known by virtue of which it can be considered true

Logical multiplication or conjunction

I have a headache and really want to sleep

$$X \wedge y$$

Kiev is the capital of Ukraine \wedge Today is sunny

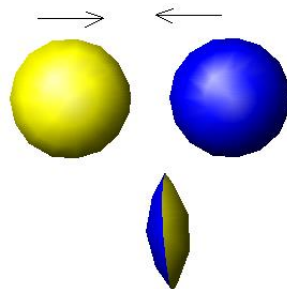


Fig.35 – conjunction

Logical addition or disjunction

It is raining now or a neighbor is pouring flowers from above

$X \vee Y$

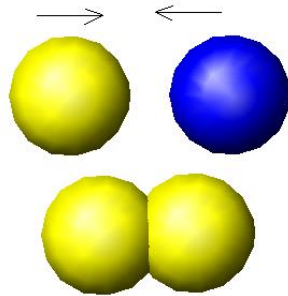


Fig.36 – disjunction

Logical negation or inversion

This operation means that the particle is NOT added to the initial logical expression or the words are WRONG THAT

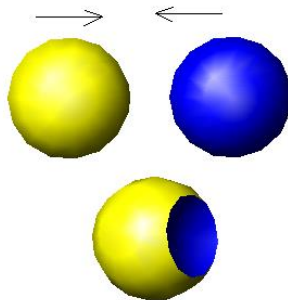


Fig.37 – inversion

Logical following or implication:

this logical operation connects two simple logical expressions, of which the first is condition (A) and the second (B) is a consequence.

Complex logical expressions

- "To be or not to be - that is the question." (V. Shakespeare) $A \vee \neg A \Leftrightarrow B$
- Either the bus did not come, or he went by car and he ran out of gas

$X \vee (Y \wedge Z)$

- The plane takes off at 8 or 9 o'clock, and in 2 hours you cannot get to the airport

$$(X \vee Y) \wedge \sim Z$$

Task 10

Three clowns, Bim, Bam and Bom, entered the arena in red, green and blue shirts. Their shoes were the same colors. Bima had the same color as his shirt and shoes. Bohm neither shoes nor shirt were red. Bam was wearing green shoes and wearing a different color shirt. How were the clowns dressed?

Fill logical tables

Table 5

	<i>Shirts</i>			<i>Shoes</i>		
<i>Bim</i>	+	-	-	+	-	-
<i>Bam</i>	-	-	+	-	+	-
<i>Bom</i>	-	+	-	-	-	+
	R	G	B	R	G	B

9.Deduction and induction

Joke

- *Holmes: Watson! Take a look at these stars and tell me what conclusion you can make using the deductive method.*

- *Watson: I see millions of stars in the sky. And since they exist, it means that there may be planets among them. From which we, in turn, conclude that some of them resemble our Earth. Consequently, on some of them life can exist.*

- *Holmes: Watson, you are an idiot. This means that a tent was stolen from us.*

Induction is a type of reasoning "from the particular to the general."

Induction (from the Latin *inductio* — leading, prompting) is a method of cognition based on formal-logical inference, which makes it possible to obtain a

general conclusion based on individual facts. In other words, this is the movement of our thinking from the partial, individual to the general.

Induction is widely used in scientific knowledge. Detecting similar features, properties of many objects of a certain class, the researcher concludes about the presence of these features, properties in all objects of this class. For example, current conductors made of different metals were used in the process of experimental study of electrical phenomena. On the basis of numerous individual experiments, a general conclusion about the electrical conductivity of all metals was formulated. Along with other methods of knowledge, the inductive method played an important role in the discovery of some laws of nature (universal gravity, atmospheric pressure, thermal expansion of bodies, etc.).

Induction used in scientific knowledge (scientific induction) is implemented in the form of the following methods:

1) the method of single similarity (in all cases, when observing a phenomenon, only one common factor is found, all others are different; therefore, this single similar factor is the cause of the given phenomenon);

2) the single difference method (if the circumstances of the occurrence of a phenomenon and the circumstances under which it does not occur are similar in almost everything and differ only by one factor that is present only in the first case, then it can be concluded that this factor is the cause of the given phenomenon);

3) the combined method of similarity and difference (represents a combination of the above two methods);

4) the method of accompanying changes (if certain changes in one phenomenon each time cause certain changes in another phenomenon, then the conclusion about the causal relationship between these phenomena follows);

5) the method of residuals (if a complex phenomenon is determined by a multifactorial cause" and some of these factors are known as the cause of some part of the phenomenon, then the conclusion follows: the cause of another part of the phenomenon is other factors that make up the general cause of this phenomenon).

Deduction is a type of reasoning “from the general” (usually to the particular, but sometimes to the general).

Deduction (from the Latin *deductio* - deduction) is a method that consists in obtaining partial conclusions based on knowledge of some general provisions. In other words, this is the movement of our thinking from the general to the partial, individual. For example, from the general statement that all metals have electrical conductivity, it is possible to make a deductive conclusion about the electrical conductivity of a specific copper wire (knowing that copper is a metal). If the initial general propositions are an established scientific truth, then thanks to the deduction method you can always get a correct conclusion. General principles and laws prevent scientists from going astray in the process of deductive research: they help to correctly understand specific phenomena of reality.

All natural sciences gain new knowledge with the help of deduction, but the deductive method is especially important in mathematics. Operating with mathematical abstractions and building their reasoning on very general propositions, mathematicians are often forced to resort to deduction. And mathematics is probably* the only deductive science.

Induction is a type of reasoning "from the particular to the general."

Deduction is a type of reasoning “from the general” (usually to the particular, but sometimes to the general)

- Induction - a way of reasoning from particular propositions to general conclusions

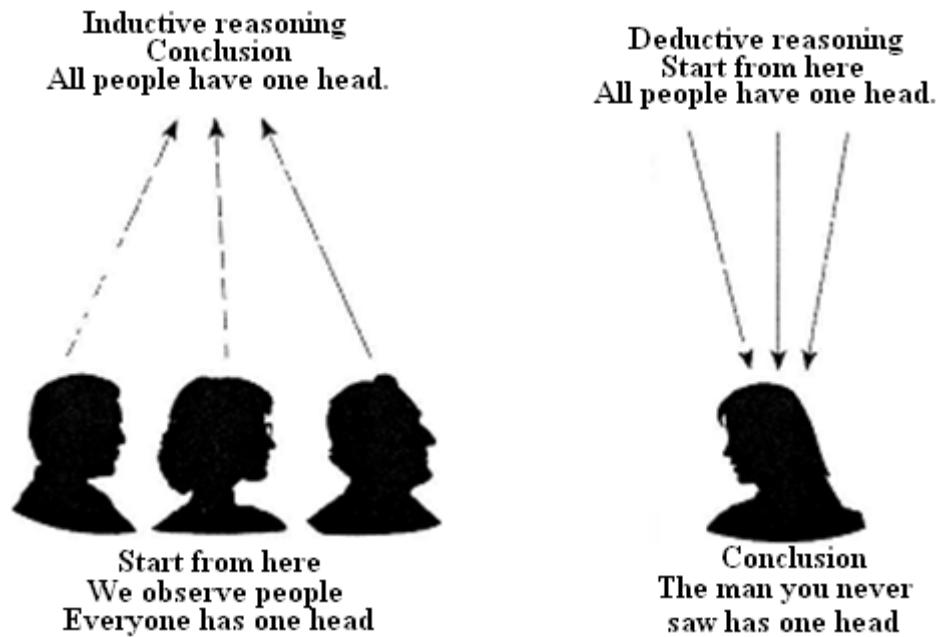


Fig.38 – inductive and deductive reasoning

Examples of inductive reasoning

- Every year of my life it was cold in winter, it is ALWAYS cold in winter,
- " All the rooks that I have ever seen are black, then ALL the rooks are black"
- “Petrov did not cope with his production task yesterday. Petrov today did not cope with the task. Therefore, Petrov is not able to perform production tasks ”
- “In March, sales increased. In April, sales increased. We are waiting for further sales growth ", " Previously, we always acted in this way, and this brought success. Why change approaches? ”

“No amount of observations of white swans can lead to the conclusion that all swans are white, but observation of a single black swan is enough to refute this conclusion.” Nassim Taleb "Fooled by Accident".

Abduction is a cognitive procedure of accepting hypotheses, a type of reductive conclusion; is that from a statement that is a conditional statement and a conclusion another statement follows.

Abduction (abductive inference) can be considered alongside induction and deduction. Selecting the most essential ones from a huge number of hypotheses, researchers implement the "abduction instinct", without which the development of

science is impossible. So the methodology of science should be understood as the interaction of abduction (the acceptance of plausible hypotheses that can be explained); induction (implementation of empirical testing of proposed hypotheses) and deduction (a method by which new statements are derived from accepted hypotheses). The idea of abduction can be formulated as follows: D is a lot of facts, H is a lot of proposed hypotheses, H explains D. Therefore, the hypotheses from H are plausible.

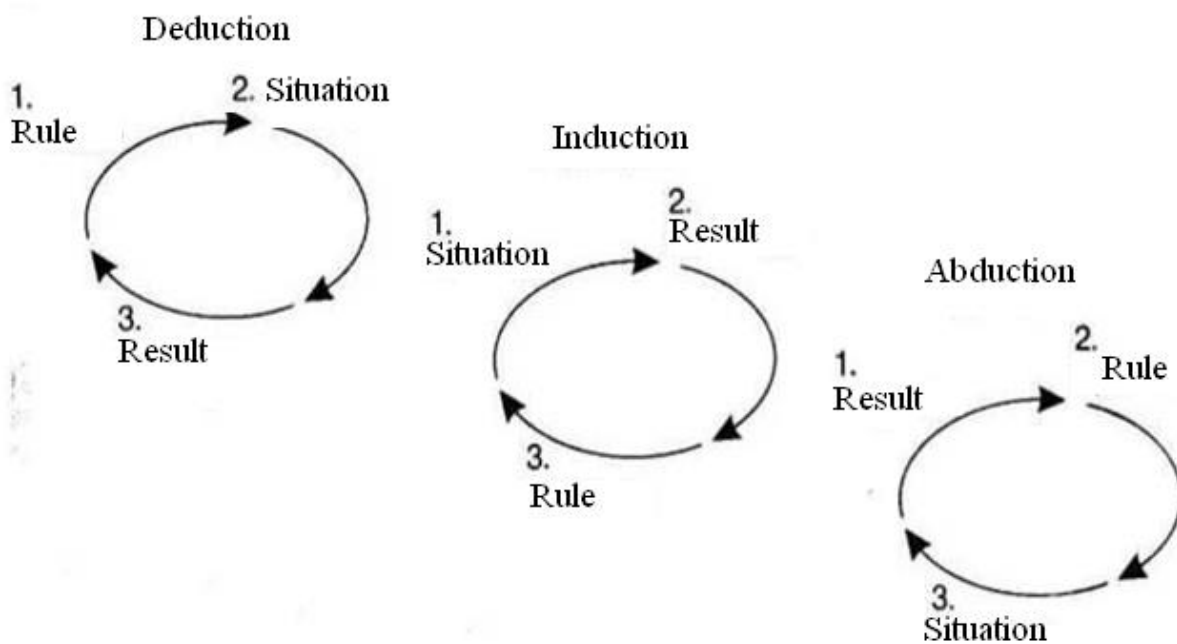


Fig.39 – Deduction, Induction, Abduction

Task 11

Solve an individual task according to the schedule of independent work.

10. Fundamentals of probability theory and mathematical statistics

- An event that is credible as a result of a test (the implementation of certain actions, a certain set of conditions) is sure to occur. $P = 1$

- An event that is not known to occur as a result of a test is called impossible.

$P=0$

- Accidental if, as a result of a test, it can either happen or not $0 < P < 1$
- The probability of occurrence of an event in some test is called the ratio

$P=m/n$, where:

- n – the total number of all equally possible, elementary results;
- m - the number of results conducive to the event.

Elements of combinatory

Permutations

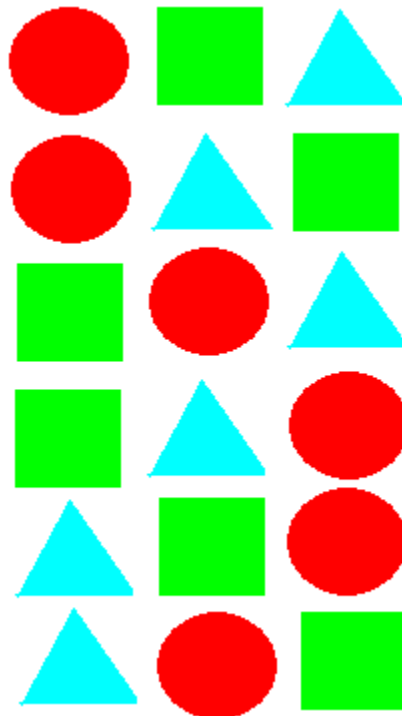


Fig.40 – Permutations

Quantity of possible variants

$$P_n = n! = 1 \cdot 2 \cdot 3 \cdot \dots \cdot (n-1) \cdot n$$

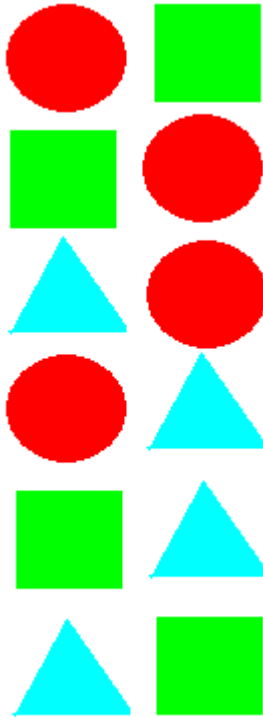


Fig.41 – Accommodations

Quantity of possible variants

$$A_{mn} = n!(n-m)!$$

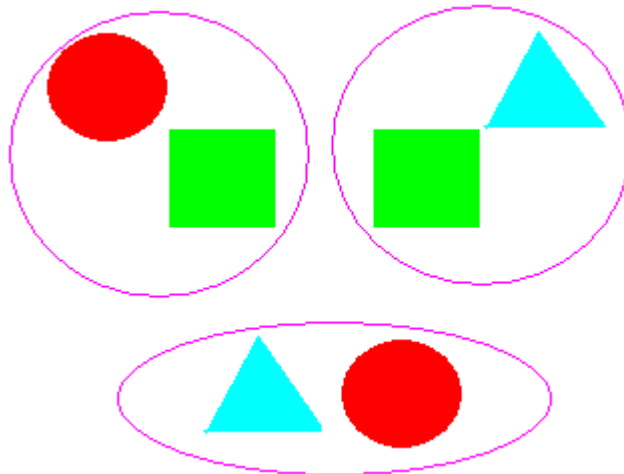


Fig.42 – Combinations

Quantity of possible variants

$$C_n^m = \frac{n!}{(n-m)! \cdot m!}$$

Discrete and continuous random variables

- Discrete is a random variable that takes individual, isolated possible values.

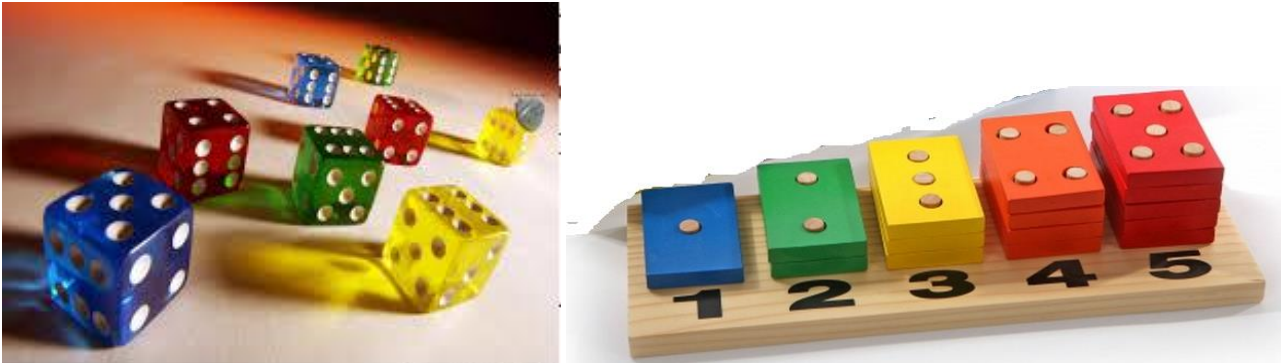


Fig.43 – Examples of discrete variables

Task 12

Perform the calculation of combinatorial characteristics according to the individual task

11. Continuous random variables

- Random variable, the set of values of which completely fills a certain numerical interval, the number of possible values is infinite

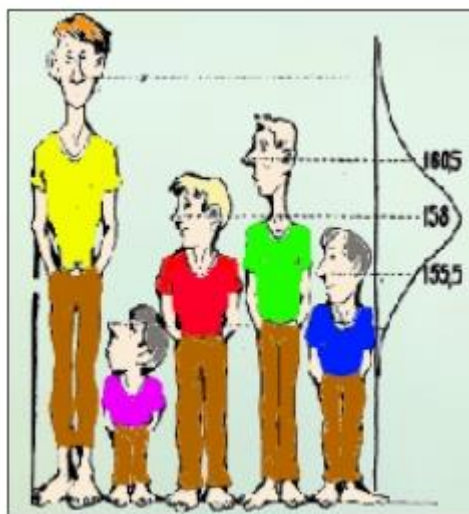


Fig.44 – Continuous random variables

The probability that a random variable X takes a value less than x is called the distribution function

The relative frequency (or simply the frequency) of a random event A is the ratio of the number n_A of occurrences of this event to the total number n of tests performed. At the same time, we assume that the relative frequencies of random events are close to their probabilities.

The empirical probability distribution of a random variable X , whose graphical representation is called a histogram

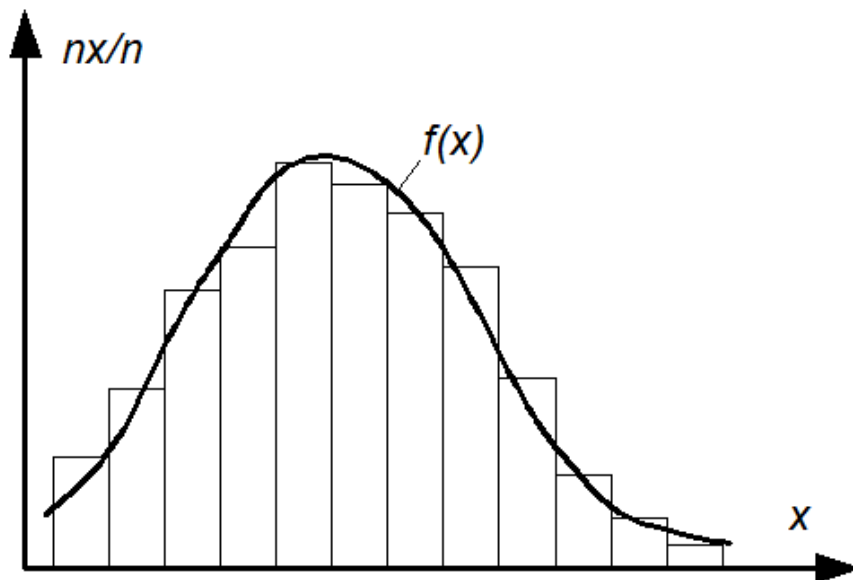


Fig.45 –Histogram of random variable

The expectation is a number around which the values of a random variable are concentrated.

The expectation can be found as the average of number of quantities.

Dispersion is a measure of the dispersion of a random variable.

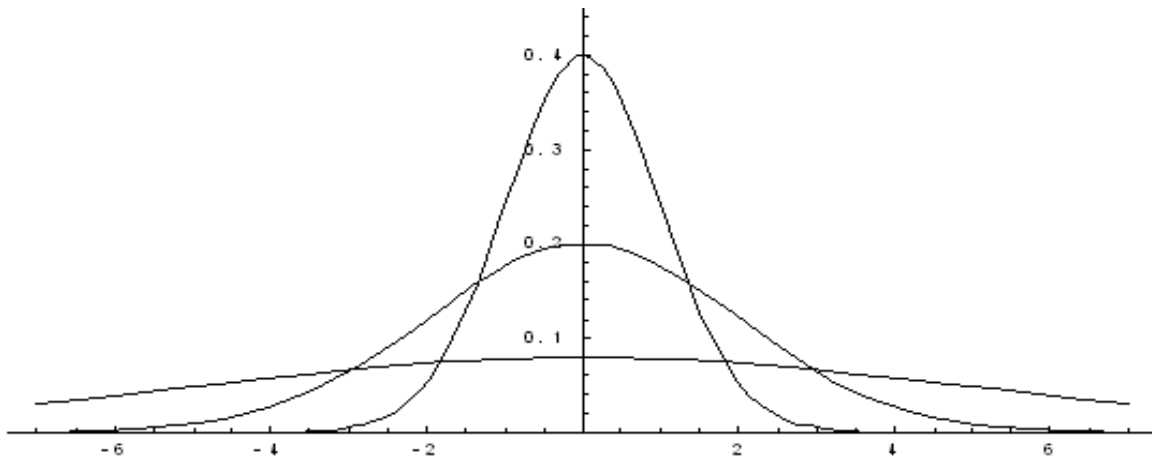


Fig.46 – Distributions of random variables with different variance

The normal distribution of a random variable is described by the expression

$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} \cdot e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

The probability for a continuous quantity is defined as the area under the probability density graph.

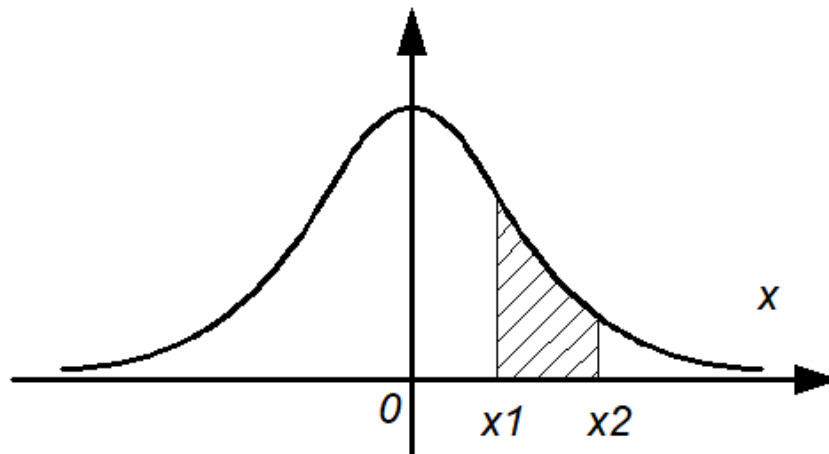


Fig.47 –Probability for a continuous quantity

Task 13

Encourage a histogram of distribution of individual data

Correlation - the interdependence of two or more random variables.

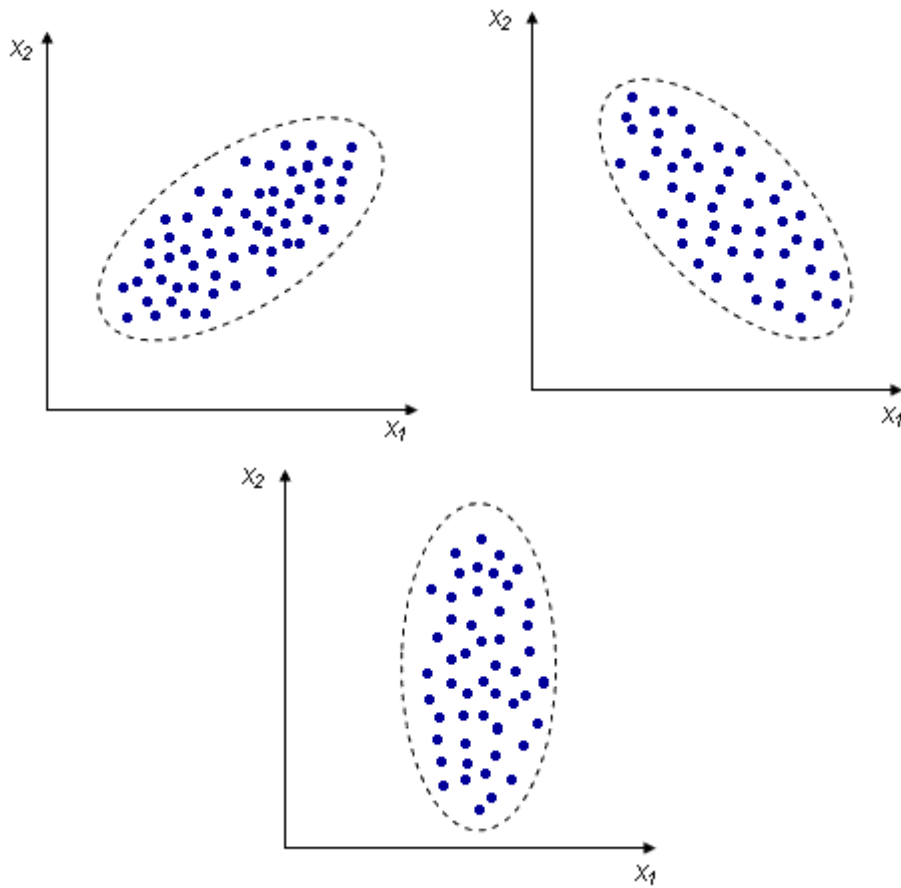


Fig.48 – Correlation between two parametres

Correlation coefficient shows degree of proximity of two parameters. Figure 44 shows high and low degree of correlation

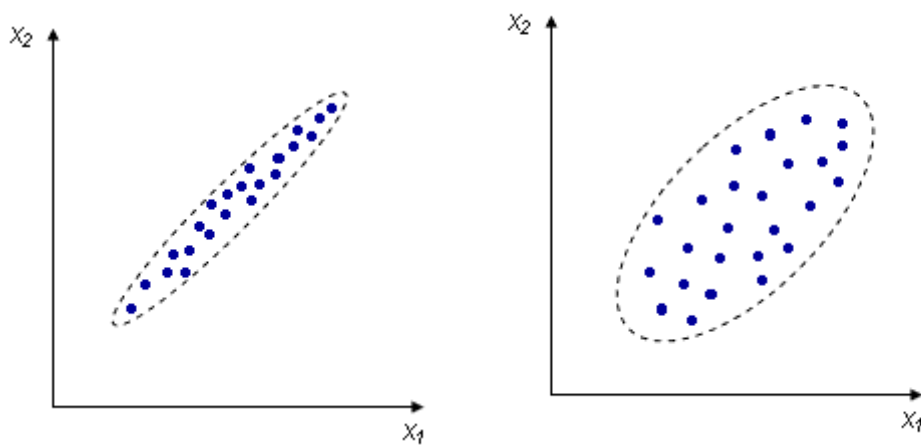


Fig.49 – high and low degree of correlation

Correlation coefficient is calculated by expression. Degree of correlation in dependence of coefficient is shown in table 2.

$$r = \frac{\sum (X_{1,i} - \mu_1) \cdot (X_{2,i} - \mu_2)}{\sqrt{\sum (X_{1,i} - \mu_1)^2} \cdot \sqrt{\sum (X_{2,i} - \mu_2)^2}}$$

Table 6

Dependence of correlation and coefficient

Strong correlation	More than 0,70
Middle	from 0,50 to 0,69
Mild	from 0,30 to 0,49
Low	from 0,20 to 0,29
Very low	Less than 0,19

The least squares method determines the search for a relationship that best matches two quantities that are in a correlation relationship. This relationship is called regression.

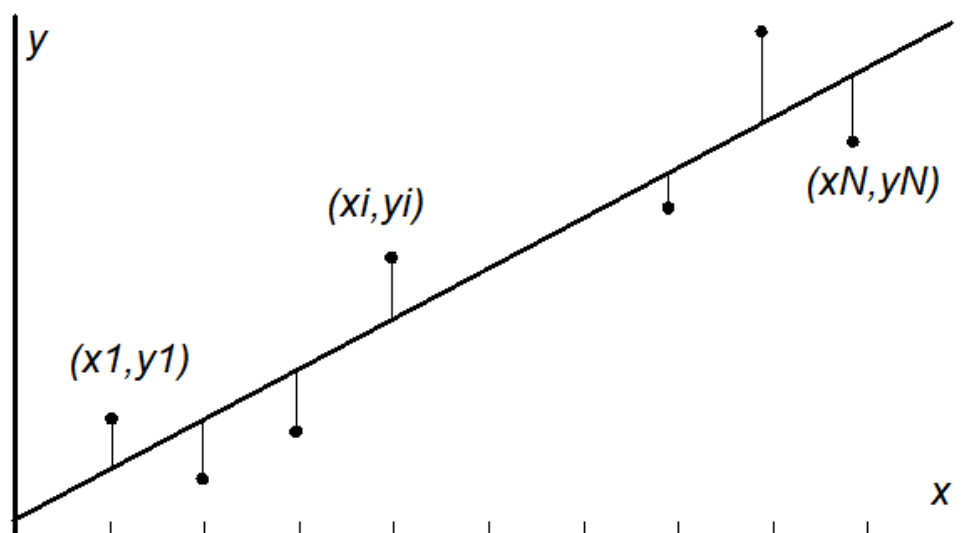


Fig.50 – Line regression

Table 7

Least squares table

N_0	X	Y	X^2	X·Y
1	X_1	Y_1		$X_1 \cdot Y_1$

2	X_2	Y_2		$X_2 \cdot Y_2$
...
i	X_i	Y_i		$X_i \cdot Y_i$
...
N	X_N	Y_N		$X_N \cdot Y_N$
Σ				

Determination of regression coefficients

$$Y = a + b \cdot X$$

$$\begin{cases} Y_i = a \cdot N + b \cdot \sum X_i \\ \sum Y_i \cdot X_i = a \cdot \sum X_i + \sum X_i^2 \end{cases}$$

Example

Table 8

Experimental data

N _o	X	Y
1	2	1
2	3	2
3	4	5
4	6	7

Table 9

Calculating table

N _o	X	Y	X^2	$X \cdot Y$
1	2	1	4	2
2	3	2	9	6
3	4	5	16	20

4	6	7	36	42
Σ	15	15	65	70

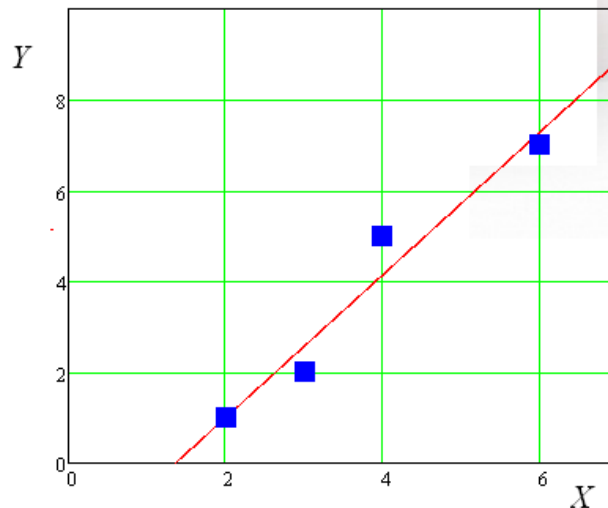


Fig.51 – Regression line

$$Y = -2,143 + 1,571 \cdot X$$

Task 14

Determine the correlation and build a regression according to individual assignments.

12. Expert assessment methods

Expert research methods are used in the following cases.

- 1) when an object or a phenomenon either completely or partially defies objective description or mathematical formalization;
- 2) in the absence of sufficiently representative and reliable statistics on the characteristics of the object;
- 3) in conditions of high uncertainty of the environment of the object, especially the market environment;
- 4) with medium- and long-term forecasting of new markets, objects of new areas of industry, subject to the strong influence of innovation;

- 5) in cases where either the time or the funds allocated for forecasting and decision-making do not allow the problem to be investigated using formal models;
- 6) there are no necessary technical means of modeling, for example, computer technology with appropriate characteristics;
- 7) in extreme situations.

Types of expertise

- Individual and collective
- Single-level and multi-level
- With the exchange of information between experts and without
- Anonymous and open

Typology of methods

- Subjective
- Objective
- Naive
- Casual
- Linear
- Nonlinear

Subjective methods

- Assume fuzzy processes for data analysis
- All data is converted in the analyst head

Objective methods

- Build on well-defined processes.
- Conversion Processes Can Reproduce Other Researchers

Naive methods

- Do not pretend to establish causal relationships
- Analyze data only for a specific variable.
- Revealed historical dynamics projected for the future

Casual methods

- Are interested in not only the question “how?”, But also the question “why?”
- Establish a causal relationship to the dependent and independent variable

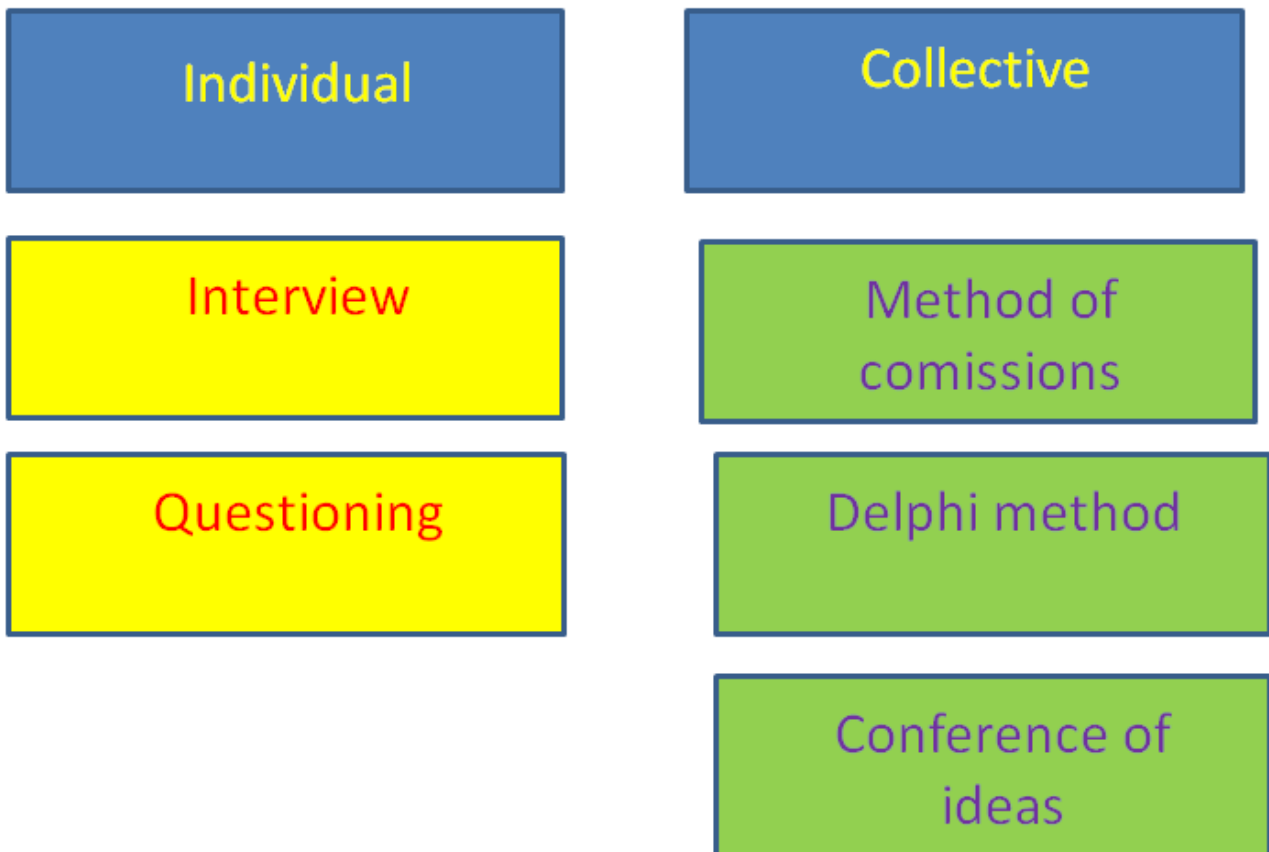


Fig.52 - Methods of expert assessments

Interview method

- researcher and expert are in direct contact. The necessary information is obtained during the conversation.
- three main forms of interviewing: free conversation; question-and-answer interview; cross-examination interview
- The “ideal” interviewer should be healthy, calm and confident, inspire confidence, be sincere, cheerful, show interest in the conversation, be neatly dressed, well-groomed. Empirically found that the most suitable interviewers are women aged 35-40 years with higher education and sufficient life experience.

Questionnaire

- The expert is asked to fill out a questionnaire containing a set of questions, each of which is logically related to the central task of the study.
- questions of two types: open and closed.

- The advantage of open questions is the ability to discover new, original solutions to the problem with the help of an expert, and their disadvantage is the complexity of analyzing answers

Methods for measuring objects in a survey

- Ranking is the arrangement of objects in ascending or descending order of some inherent property.

- Pairwise comparison is the establishment of preferences for objects when comparing all possible pairs.

- Immediate evaluation. The range of changes in the characteristics of an object is divided into separate intervals, each of which is assigned a certain score (score), for example, from 0 to 10.

The simple ranking method consists in asking each expert to rank the features in order of preference.

Table 10

Weighting method

	1	2	...	j	...	m
1	A_{11}	A_{12}	...	A_{1j}	...	A_{1m}
2	A_{21}	A_{22}	...	A_{2j}	...	A_{2m}
...
i	A_{i1}	A_{i2}	...	A_{ij}	...	A_{im}
...
n	A_{n1}	A_{n2}	...	A_{nj}	...	A_{nm}

A_{ij} - evaluation of the feature by an expert. n is the number of features, m is the number of experts.

Weighting method

- all features are assigned weight coefficients so that the sum of the coefficients is equal to some fixed number (for example, one, ten or one hundred);

• the most important of all attributes is given a weight coefficient equal to some fixed number, and all the rest are given coefficients equal to fractions of this number.

Pair comparison can be carried out with a large number of objects, as well as in cases where the difference between objects is so insignificant that it is practically impossible to rank them.

Table 11

Pair comparison

	1	2	...	j	...	n
1	A_{11}	A_{12}	...	A_{1j}	...	A_{1n}
2	A_{21}	A_{22}	...	A_{2j}	...	A_{2n}
...
i	A_{i1}	A_{i2}	...	A_{ij}	...	A_{in}
...
n	A_{n1}	A_{n2}	...	A_{nj}	...	A_{nn}

2 if object i is preferable to object j ($i > j$),

1 if object equality is set ($i = j$),

0 if object j is preferable to object i ($i < j$).

Table 12

Development of the paired comparison method using the relative importance scale

Degree of preference	Definition	Explanation
0	Independence	The expert finds it difficult to answer
1	Equal importance (significance)	Are of equal importance
2	Some (weak) preference for	The difference in importance is

	significance	point
3	Strong preference for significance	The difference in importance is 2 points
4	Very strong preference for significance	The difference in importance is 3 points
5	Absolute preference for significance	The difference in importance is 4 points

Commission method

- Involves regular meetings of experts to hold group discussions on the problem under discussion and develop an agreed solution during such discussions.

The Delphi method got its name from the ancient city of Delphi, where the temple for predictions was located.

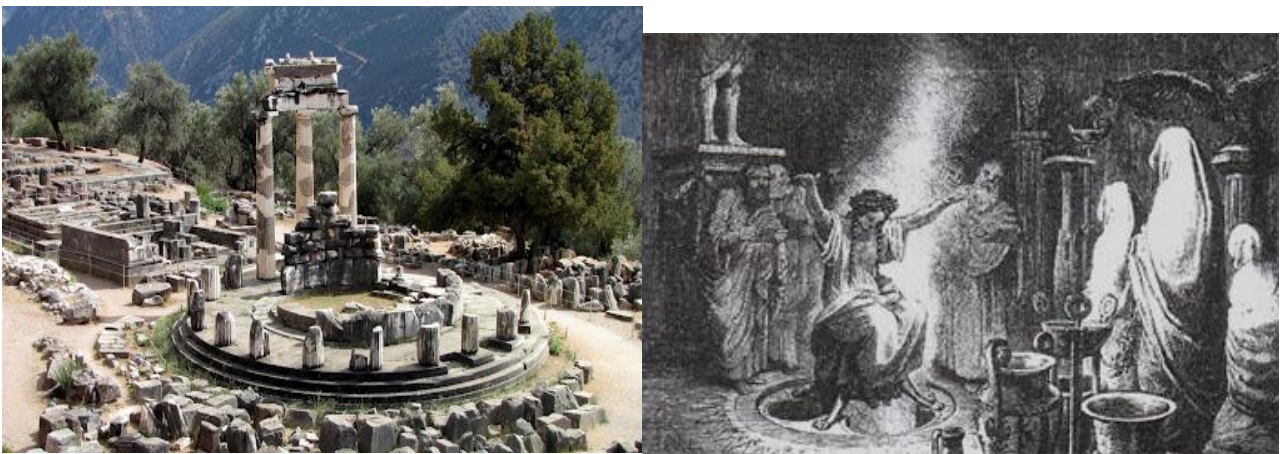


Fig.53 – Delphi Temple

The Delphi method creates two groups of people

- The first group are experts who present their point of view on the problem under study
- The second group is analysts who bring expert opinions to a common denominator

The first stage is the selection of an expert group. It can include any number of people, but it is recommended to form a group of 20 people and no more.

The main stage consists of the following steps:

- A problem is posed – the experts receive the main question, and their task is to break it down into several smaller ones.

- The resulting questionnaire is again presented to the experts.

- Now they need to propose their own ways of solving the problem and explore the alternative positions of other experts.

- Analysts highlight the main opinions of experts and try to bring them together.

If someone's opinions run counter to the opinion of the majority, these opinions are voiced to the experts. As a result, experts can change their positions, after which this step is repeated again.

- The steps are repeated over and over again until the experts reach a consensus and a consensus is established. In the end, an overall assessment is made, and practical recommendations are made to solve the problem.

Task 15

Conduct an analysis of the method of expert assessments conducted in a practical lesson in the classroom.

13. Analysis and Synthesis

Analysis is a logical technique, a method of research, consisting in the fact that the object under study is mentally (or practically) divided into constituent elements (attributes, properties, relationships), each of which is studied separately as part of a divided whole.

Analysis is the decomposition of a complex phenomenon into its components, simpler elementary parts and the selection of individual aspects, properties, and connections. However, analysis is not the ultimate goal of scientific research. This goal is achieved by this method of research, which consists in combining,

reproducing the connections of individual elements, sides, components of a complex phenomenon and thus in understanding the whole in its unity of its components. Analytical method is a tool for careful study of the features and specifics of intra-systemic interaction, and it necessarily contains the results of abstraction, simplification, and formalization. It's just that all this is not an end in itself, the essential task of the analytical method is that it is aimed at identifying internal trends and opportunities for the object's development.

Synthesis - a logical technique by which individual elements are combined into a whole.

Synthesis is the opposite of connecting the components of a complex phenomenon. Synthetic knowledge - knowledge that expands previous experience, constructs something new. Distinctive power. The synthesis is that this method implements itself beyond the framework of the existing basis (for example a person, analyzing the movement of dolphins in the water, used the obtained conclusions to create first primitive boats, then sailboats, steamships and steamships)

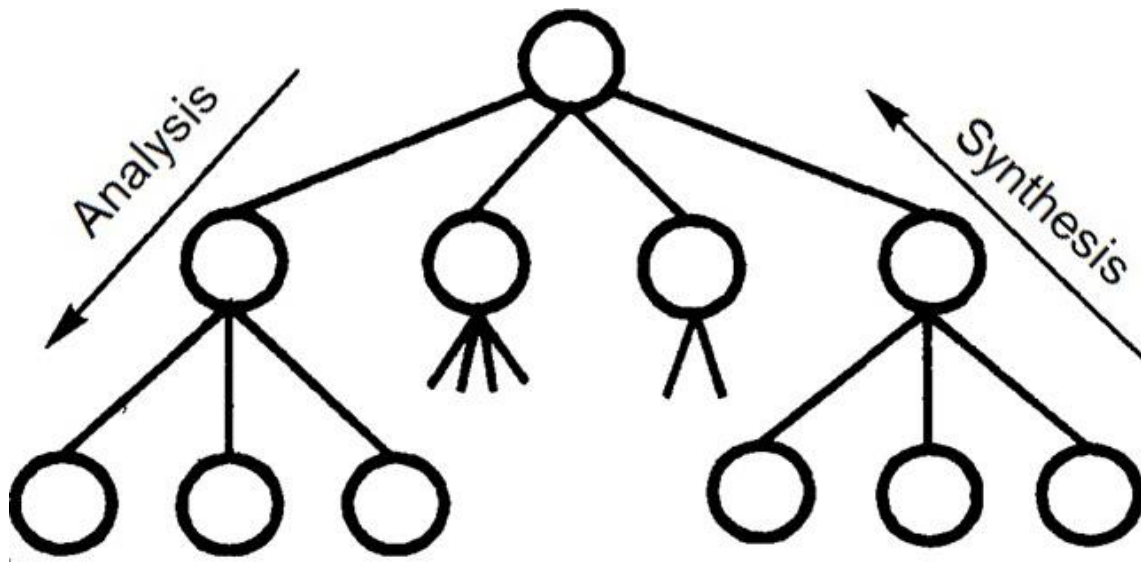


Fig.54 - Analysis and synthesis

Analytical methods can include following directions.

Separation

In how many ways can you divide a square into four equal parts? Try to find ten different ways

Classification

Allows you to organize the material under study, grouping the set (class) of the objects under study into subsets (subclasses) in accordance with the selected feature

It is convenient to reflect in the form of tables or diagrams (graphs)

Systematics (Taxonomy)

• Systematization is based on the classification of a sufficiently large amount of material

The unit of taxonomy is called a taxon.

Criteria

- What criteria would you use when evaluating:
- movie,
- TV show,
- contemporary art,
- white wine,
- fashion collections,
- potato chips,
- cars,
- emeralds.

Analysis and synthesis have four varieties.

The first type is natural analysis, which implies the separation of objects into parts, and natural synthesis - combining these parts into new objects in strict accordance with the possibilities available in nature.

The second type is practical analysis, which means separating subjects into components, and practical synthesis - combining these components, according to the possibilities of practice, which could not be realized in nature.

Imaginal analysis and imaginal synthesis are the third variety. It means the separation or connection of something that is impossible neither in practice nor in nature. Meta-analysis and meta-synthesis is the fourth type, analysis and synthesis of knowledge about the world.

Below are some examples of the use of synthesis in scientific research.

Extend the lists of the following items and concepts combined into one category

Table 13

Categories

Food: fruits, meats, proteins, carbohydrates...
Sciences: physics, paleontology, pseudoscience...
Music: rock, classical, musical instruments, show business...
Jurisprudence: court, investigation, police, sentence...

Subsequence

Dividing a large and complex plan into a series of simple actions. Describe in detail the steps you need to take to complete the projects below.

- Purchase and operation of a personal computer.
- Investing money in real estate.
- Fur seal training.
- Make a trip to Timbuktu.
- Learn the Farsi language.
- Become a lighter in a rock band.
- Build an extension to your house.
- Make a hunting knife.
- Change the electrical wiring in the house.
- Build a new bath in the house.
- Organize vaccinations in third world countries.
- Publish a new newspaper.
- Open a French restaurant.

Table 14

Assumptions

Distance
How far from your eyes is your left index finger?
How far is the nearest nuclear power plant from you?
How far will you walk in your ten average steps?
How far is it from where you are to India? To Sweden? To the Maldives?
Weight

How much does a dandelion leaf weigh?
How many chicken eggs do you need to take so that their weight is equal to the weight of the car?
How much does the air weigh in the room where you are?
How much does your head weigh? Your left hand? Leg?
How much water do you consume during the year? How much sugar? How much salt?
Sizes
What are the room sizes in your apartments?
What are the room sizes of your kitchen table? Chairs? Windows?
What are the main parameters - height, weight, clothing sizes - of your spouse?
Choose three persons and evaluate their parameters.
What is the size of a red blood cell, a carbon atom, the sun, a protein molecule, a computer processor, a virus, a dinosaur, our galaxy?

In some cases, synthesis is considered as the ability to summarize fragments of information. Examples can be tasks to extend the sequence of 1, 4, 12, 52, ... or the selection of missing objects (Fig. 55).

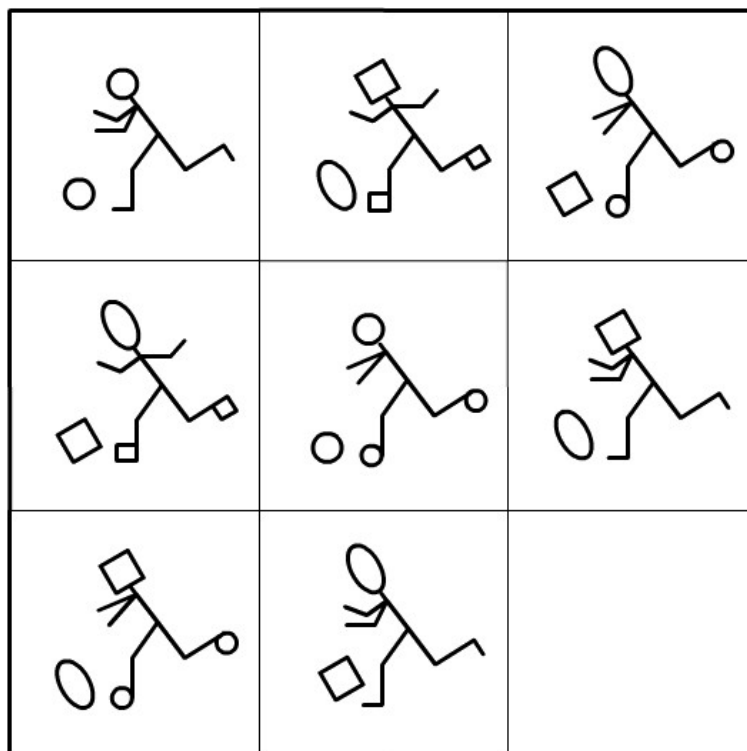


Fig.55 – Tasks for determining IQ

Task 16

Complete IQ tests according to the self-study schedule

14. Systemic approach

A systemic approach is a direction in the methodology of scientific knowledge, which is based on the consideration of an object as a system: an integral complex of interrelated elements, a set of interacting objects, a set of entities and relationships

The main principles of the system approach

- unity - the system is considered as a whole and as a set of parts;
- integrity - elements can be of different directions, but they are compatible at the same time;
- dynamism - the system's ability to change its state under the influence of directional or random factors;
- interdependence of the system and environment, ie. the system manifests its properties in the process of interaction with the environment;
- hierarchy - ie. ranking of parts, each element of the system is considered as a subsystem, and the system itself is considered as an element of a more complex system;
- organization - putting in order the components and links that unite them;
- multiplicity of states and descriptions of the system - construction of various models, each of which describes a certain state of the system;
- decomposition - the possibility of dividing an object into component parts, each of which has goals arising from the overall goal of the system.

Perspectives for considering a systematic approach

- elemental, showing what elements the system consists of during its construction and research;
- structural, revealing the internal organization of the system, the nature of connections and ways of interaction of components;
- functional, answering the question of what functions the system itself and its components perform;

- communication, revealing the relationship of this system with others both horizontally (cooperation) and vertically (subordination);
- integrative, showing the mechanisms, factors of conservation, improvement and development of the system;
- historical, answering the question of how, how the system arose, what stages it went through in its development and what are the trends (prospects) of its development.

Main goals

- The task of analysis is to determine its functioning (behavior).
- The task of synthesis - the nature of the functioning and other requirements for the system are given, it is necessary to determine the structure that satisfies the requirements.
- The task of the "black box" - a system is given, the structure of which is unknown or partially known, to determine its functioning and, possibly, its structure.

Links are what connects objects and their properties in a system process into a whole

There are first-order connections - functionally necessary; second-order connections - improving the operation of the system, but not functionally necessary; third-order connections - redundant or contradictory

Morphological analysis of systems

- determination of the elemental composition, search and description of links between the elements of the system.
- Formulation of the task (problem).
- Compilation of a list of all morphological features of the task object, i.e. all important characteristics of the object, its parameters and modes of operation, on which the implementation depends!

object of its main purpose.

- Disclosure of possible options for each morphological trait and compilation of a morphological matrix!

Formulation of specific solutions to the problem by combining variants of morphological features.

- Determining the practical value of the obtained options for solving the problem and choosing the most effective among them

Types of systems are shown on fig. 56-59

Abstract systems consist of elements that have no physical analogues in the real world. For example, systems of equations, systems of calculations, ideas, plans, hypotheses, theories, etc.

Artificial systems are man-made systems.

Simple systems are those that can be described with sufficient accuracy.

Large complex systems consist of numerous interdependent and interacting heterogeneous elements and subsystems. Complex systems have fundamentally new properties that none of the constituent elements has (emergence property). Examples of complex systems: a living organism, an enterprise, a branch of the economy, a telecommunications management system, etc. Such systems are characterized by a high level of uncertainty in their behavior.

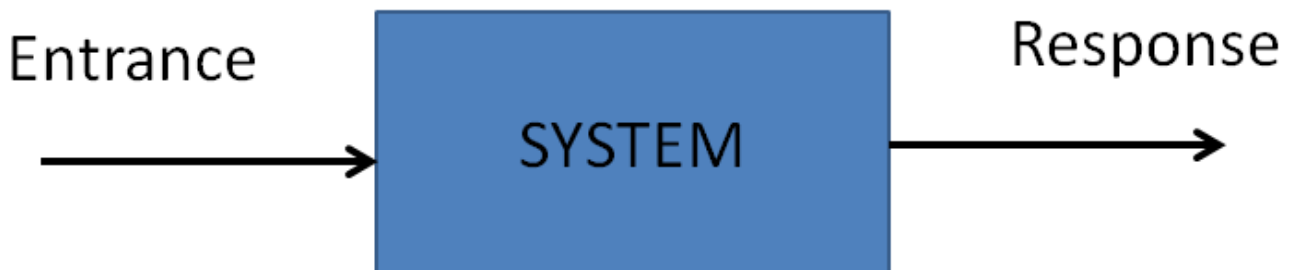


Fig.56 – Simple system

A sorting algorithm is a process that arranges a set of elements of the same type according to a certain characteristic (sorting key). Sorting is a typical data processing problem that arranges the elements of an unordered set of values in monotonically increasing or decreasing order of key value.

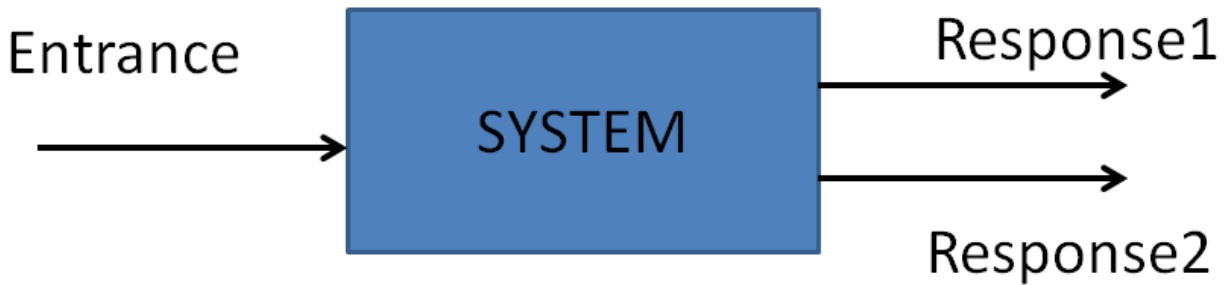


Fig.57 - Sorting system

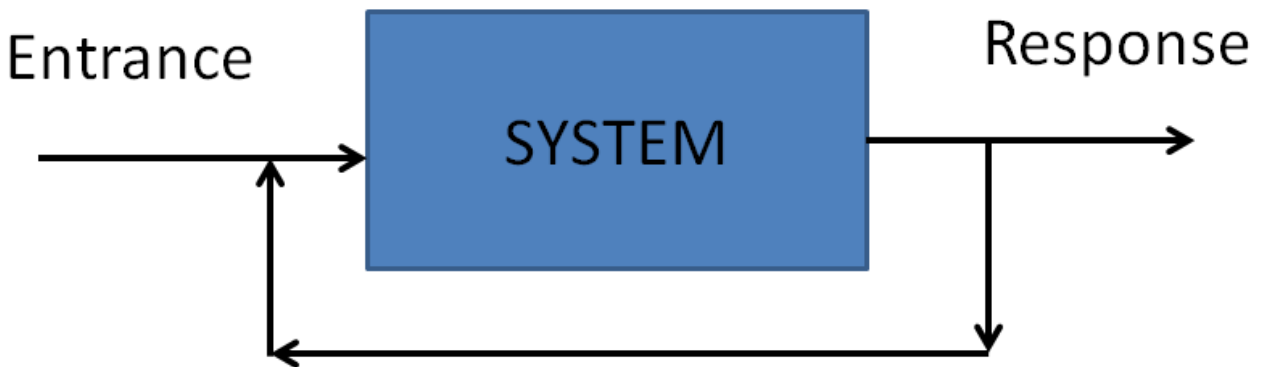


Fig.58 - Feedback system

There are two main types of systems: closed and open.

A closed system is a system isolated from the external environment, the elements of which interact only with each other, having no contact with the external environment.

An open system is a system that interacts with its environment in some aspect: information, energy, material, etc.

All organizations are open systems, their survival depends on the outside world. The organization exchanges energy, information, and materials with the external environment through permeable borders. An open system is not self-sustaining because it depends on energy, information, and materials coming from outside. In addition, an open system has the ability to adapt to changes in the external environment and must do so in order to continue its functioning.

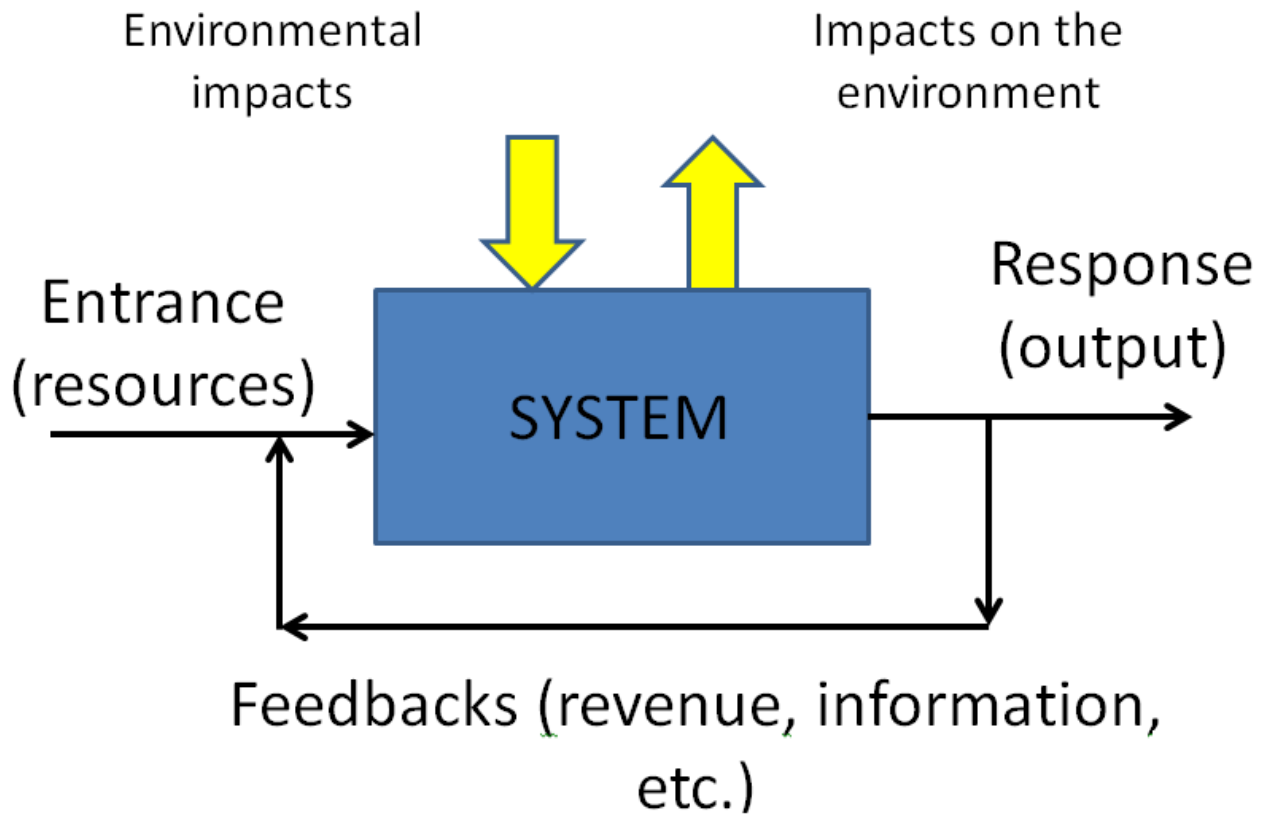


Fig.59 – Open and closed systems

A model is a representation of an object, system or concept in some abstract form that is convenient for scientific research.

Modeling is the most effective way of researching complex systems of various purposes - technical, economic, ecological, social, informational - both at the stage of their design and during operation. The possibilities of system modeling are far from exhausted, so the newest modelling methods and technologies are constantly appearing.

Task 18

Consider certain clothes in agreement with the teacher, as a system. Develop a model of this system.

15. Structure of science article

Description of scientific research as a whole or any of its components includes a scientific text. It is also a symbolic form of scientific knowledge. You cannot create a scientific text without conducting scientific research. Young scientists are primarily focused on writing a dissertation, not on researching a problem and then presenting its solution in the text of the dissertation. A text written with such an attitude is quite often a collection of some unsubstantiated, though correct, statements. It is normative, not research in nature, because the truth can be expressed in only one way - with the help of its justification.

Problematicity, coherence, hypotheticality, purposefulness are important characteristics of a scientific text. The text is oriented towards the achievement of the research goal and tasks, necessarily reflects one or another problem, puts forward hypotheses, orients to new knowledge, is characterized by the expediency and rationality of all provisions.

In general, scientists distinguish three parts of a scientific text: production, research and conclusion.

The introductory part of the text defines the problem, goal and task, hypotheses, research methods, and also notes the connection of this study with other studies. The research part of the text describes the conducted research and the obtained results. In the final part of the text, conclusions are drawn and recommendations are given for conducting further scientific research and using the results in practical life.

Review, methodological, empirical-factual, theoretical, explanatory and additional scientific text is a peculiar mixture of several types of simple texts.

Review text, which is a review of scientific literature on the researched problem. To provide scientific substantiation of the subject of research, to establish the limits of this research, to show the degree of unstudiedness of its individual components - this is the main purpose of the review text.

The methodological text is a description of the principles, approaches, paradigms, methods and other components of the research toolkit. It serves to substantiate and describe the specifics of the methodology of the conducted research.

The empirical-factual text contains a description of the factual base of research, classification and generalization of facts. The components that must be clearly defined are the factual basis of each study. At the same time, it is mandatory to justify the legality of using these facts in this research context. For example, in a number of cases, statistical data of sociological studies conducted by other researchers are used. It is important to substantiate the possibility of operating with these data in the conducted research.

The theoretical text gives an account of the theoretical aspects of the vision of the subject of research, its explanation from the point of view of formulated regularities, trends, concepts, etc.

Explanatory text is a verbal structure that is intended to explain the provisions of other types of text. These are, in fact, various notes and explanations, as well as the introduction of various dictionaries of basic and additional concepts, explanations of tables, diagrams, schemes, plans, graphs, formulas, etc.

Additional text may include additional arguments, unique facts, charts, graphs, statistical material, etc. Usually additional text is placed in the appendices. Annotations, abstracts, synopses, reviews, reviews are examples

A special genre of texts that combines scientific research with its justification is a scientific work. Note that the first part of the work describes the current state of the research field, outlines the theoretical and methodological principles of scientific research, and describes its main stages and results. The rationale for solving the previously formulated problem is given, and the results and directions of their implementation are given on the following pages.

A scientific text is characterized by completeness, substantive integrity, logic and brevity. Special functional and syntactic means of communication indicating the sequence of thought development are the most important means of expressing logical

communication. It is necessary to use expressions that reflect a cause-and-effect relationship, such as:

- therefore, according to what;
- due to the fact that;
- due to the fact that;
- in addition to this, etc.

Before moving on to another opinion, you should refer to the following sayings:

- before pointing to;
- should be considered;
- let's stop at etc.

Conclusions should begin with the following phrases:

- so;
- on completion;
- the above allows us to draw the following conclusions;
- generalizing should be defined, etc.

It should be noted that language expressions speak about the logic of thought, prevent false repetitions, direct the course of thought, observing the rules of scientific research in accordance with the sections of the study.

Conclusions

The manual discusses the main issues of the methodology of scientific research. Separate sections are dedicated to the processes of training scientific personnel in Ukraine and the world, the concept of the scientific method, the main features of the dialectical theory of knowledge. The object and subject of research, the main research methods are described. In particular, deduction and induction, analysis and synthesis, and a systematic approach are described. The basics of the theory of probabilities and mathematical statistics, correlation and regression methods, methods of expert assessment are presented. Each section is accompanied by tasks for individual work that build skills and also challenge the use of communication and judgment processes in learners.

References

1. Steps of the Scientific Method. <https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method>
2. Blakstad O. Scientific Method. How Knowledge is Made. [Electronic resource] Retrieved (Dec 6, 2012). - Access mode Sep 18, 2022 from Explorable.com: <https://explorable.com/scientific-method>
3. Centellas M. Research Methods Handbook. Oxford: - University of Mississippi. – 2016. -90 p.
4. Handbook of Research Methodology. Dwarka, New Delhi. -2019- 28p
5. Stephe N.S. Beginner's Guide to Scientific Method./ Stephe N.S., Carey A. –Wadsworth: -Cengage Learning.-2004.-143 p.
6. John H. McDonald Correlation and linear regression. Handbook of biological statistics <http://www.biostathandbook.com/linearregression.html>
7. Samprit Chatterjee, Jeffrey S. Simonoff Handbook of Regression Analysis. Wiley. -2012. -252 p.
8. Quade E.S., Miser, H.J. Handbook of Systems Analysis: Volume 1. Overview. Chapter 1. The Context, Nature, and Use of Systems Analysis. IIASA Working Paper. WP-81-131. -1981. -48 p.
9. Harris Cooper, Larry V. Hedges, And Jeffrey C. Valentine. The Handbook of Research Synthesis and Meta-Analysis.- New York:- Russell Sage Foundation. -2009. -610 p.

P98

Science methodology. Методологія наукових досліджень (англійською мовою): конспект лекцій для здобувачів другого (магістерського) рівня вищої освіти освітньої програми «Технології та дизайн у модній індустрії» спеціальності 182 Технології легкої промисловості галузі знань 18 Виробництво та технології денної та заочної форми навчання/ уклад. М. Л. Рябчиков. Луцьк: ЛНТУ, 2022. 62 с

Розглянуті основні питання методології наукових досліджень. Окремі розділи присвячені процесам підготовки наукових кадрів в Україні та світі, поняття наукового методу, основні риси діалектичної теорії пізнання. Описані об'єкт і предмет дослідження, основні методи дослідження. Зокрема описані дедукція та індукція, аналіз і синтез, системний підхід. Наведені основи теорії ймовірностей і математичної статистики, кореляційні і регресійні методи, методи експертної оцінки. Кожний розділ супроводжується завданнями для індивідуальної роботи, які формують уміння, а також викликають використання комунікацій і процесів формування суджень у здобувачів освіти.

Комп'ютерний набір
Редактор

М.Л. Рябчиков
М.Л. Рябчиков

Підп. до друку _____ 2022 р.
Формат 60x84/16. Папір офс. Гарнітура Таймс.
Ум. друк. арк. ____ Тираж ____ прим. Зам. _____

Інформаційно-видавничий відділ
Луцького національного технічного університету
43018 м. Луцьк, вул. Львівська, 75
ІВВ ЛНТУ