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Types of scientific research

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Oznaczenie Licencyjne

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Establishment of terminology

- The term *nauka* (*science/education*) comes from the Latin *scire/educare*, meaning to know/to train, and has more than one sense: didactic, institutional, or theoretical (content and functional).
- In the sense of
 1. *Didactics* it is the action of teaching and learning;
 2. *Institutions* - it is connected with the scientific discipline performed at a university or at a science-and-research institution;

3. Theory

- ***In the contents (results)*** - sense, science is understood as a complete system of informed theorems and hypotheses faithfully reflecting the image of a given area of reality (for example a natural one, or a social one, or technical), and the means to discover it and shape it in a useful way (the so-called objective knowledge).
- ***In the historical-and-sociological sense*** - science is an area of culture which includes:
 - a developing historically specialised cognitive branch of activity pursued by scholars as a separate social group (for example medicine, or law) and
 - the products of its activities in the form of systems of knowledge, equipment, research workshops, magazines, and social institutions created to practice science/education (universities, and institutes), as well as
 - dissemination of the results of scientific findings and implementing them in practice.

This is the most universal sense of the term nauka.



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- **In the functional (action) sense** - science is the totality of actions that form the research activities leading to the creation and development of science in the contents sense, in accordance with methods which are to ensure an objective, well-grounded, and orderly study of a given domain of reality.



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THE GOALS OF SCIENCE

- **INTERNAL** - meaning a faithful and exact description of the world, delivering a proper and a more-and-more perfect image of reality, **discovering the scientific truth which is timeless and irrespective of space**. These goals are accompanied by a vision of man becoming independent from many limitations and mastering the external world. **Internal goals do not presume there to be any direct practical results.**
- **EXTERNAL** - related to converting the studied objective laws of the surrounding world into proper norms and directives which ensure **effective and beneficial practical actions**. They are focused on the life needs, the broadly understood practice, on getting to know the conditions for effective action.

The division line between the cognitive and the practical goals is not sharp, they remain constantly interlocked, as in learning and practice. This relationship has the characteristic of a feedback loop, it becomes stronger, the stronger the levels of either learning or practice.



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THE FUNCTIONS OF SCIENCE

1. **Descriptive (diagnostic)** - implemented through discovering the state of a thing, its developmental tendencies, it describes the relationships present between things through the use of appropriate language.

Diagnosis answers the questions of what things are like, what are the qualities of things and phenomena, their intensity, and are they subject to changes and other processes and what might those be.

Apart from discovering the actual state, it can deliver the rationale for a desired change of that state.



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2. **Explanatory** - consists in explaining the implications, relations, and dependencies between phenomena, in establishing the cause-and-effect relationships, in answering the question: why is it like that?

As part of this function, science explains why certain events take place, what is their root, dominant, cause, and which is secondary. It also shows the circumstances in which the analysed events are transformed.

3. **Prognostic** - consists in anticipating future states of things based on the current state of knowledge.



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THE STRUCTURE OF SCIENCE

The abundance of science is seen in its progressing divide and separation into new entities, meaning scientific disciplines.

This process is connected with:

- **The accumulation of immense knowledge** which a scientific worker is unable to master (without mastering the current state, one cannot rationally impact its further development).
- **The existence "on the outskirts" of different mature disciplines** for similar problems which interest researchers, and when these are added together and synthesized they create a new discipline.
- **Giving** some fragment of reality **great social significance** and deeming that it needs scientific support.



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Types of scientific research

Classification:

1. The characteristic of the gathered material.
2. The perspective of time.
3. The place of conducting research
4. Classifying science into disciplines.



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I. The characteristic of the gathered material

1. Quantitative research.

2. Qualitative research.

Quantitative research

- Provides countable data, can be compiled in the form of numbers and subjected to mathematical and statistical procedures. It informs, for example, about frequency, size, or the intensity of an object under study.

Correctness of quantitative research requires:

- That the object of the research be strictly defined variables stemming from the hypotheses that were put forward,
- The research tools be planned and standardized beforehand;



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- The maximum number of components of the studied situation be standardized,
- It takes into consideration the requirements of statistical methods: random sampling, categorization of tools, encoding, a numerical description of the results ensuring establishment of the strength of relationships, and defining the significance of the differences between variables.

Pros:

- One gets to know the relationships between variables, for example interaction and effect;
- Comparative research taking into consideration features such as gender, age, the level of adaptation, and so on,
- Adequate communication and making gathered data objective.
- Enables the use of statistics, and a more unambiguous interpretation of the results.



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Qualitative research

is an alternative to empirical quantitative research. Provides data in the form of a description, presents an object of the research through words, the data has no numerical form.

Qualitative research is used when:

- One wants to examine phenomena in their context, one wants to get to know them as they are and not state if they conform to our expectation of them;
- The phenomenon under study is sensitive, or regards problems considered intimate, or personal, for example pain, suffering, or death,
- The people under study are entities with a high degree of self-awareness.
- Qualitative research is conducted using casual surveys, uncontrolled participant observation, or a qualitative analysis of contents.



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- **Longitudinal studies** consist in repeated studies of the same sample. The object of the study is the change of some feature over the natural flow of time or through a factor purposefully introduced into the system. This type of study is mainly used by epidemiologists in order to describe the expected effects occurring in time.
- **Cross-sectional studies** - their characteristic feature is that all the data is gathered at a single point in time. They may, for example, relate to the existence of a disease in groups of the population selected by gender, age, profession, identity, or place of residence. Most often these are one-time measurements.



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III The place of conducting research

- **Research in artificial conditions**, for example in laboratories, or rooms fitted with Venetian mirrors or other devices which register the behaviour of people or their physiological reactions to stimuli.
- **Research in natural conditions, meaning real ones**, where people behave in their normal, natural manner. Data is usually gathered through observation, but can also be obtained by way of asking questions, photographing, filming, or recording. The place to conduct this type of research can be a healthcare facility, the home environment, a school, and the like.



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IV. Classifying science into disciplines

1. Basic research - in these studies scholars search for truth, they aim to discover, learn something completely new, to build new knowledge, formulate theorems which are maximally consistent with reality. The relationship of science/education and practice is ever-present and the stronger the higher the levels of practice and science/education. They impact each other in a feedback loop mechanism.

Example: searching for the causes of a disease

2. Applied research - its aim is foremost to provide foolproof ways of dealing with tangible reality, an effective way to resolve present problems, and to improve the effectiveness of human actions.

- The assessment of applied research is done mainly basing on its usefulness and it being adequate to the needs of practice

Example: checking the effectiveness of treatment methods

Rules of gathering data and conducting analyses

Scientists want their results to reflect the truth.

- Scientific research will not provide any significant input to the evidence material, which drives clinical practice, if the results are inaccurate, distorted, do not represent the experiences and feelings of the groups under study, or interpret the gathered data in an erroneous way. The consumers of that research (people who familiarize themselves with its results) assess the quality of the provided scientific evidence through tracking the conceptual and methodological decisions of the researchers, whereas the researchers themselves have to really try to make the correct decisions in order to provide results which are of the best possible quality.



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Errors related to scientific research

Causes

- **Truthfulness of the participants of the research** - people may change the way they behave or their confessions (conscious or subconscious) in order to put themselves in the best light.
- **The subjective assessment of the researcher.** Scientists may distort information in terms of their own expectations or according to their previous experiences.
- **The characteristics of the sample.** The sample itself might be burdened with error; if the scientist is studying attitudes towards abortion, but the group under study has only the representatives of one of the trends (pro-abortion or in favour of a foetus's right to live), the results will be distorted.



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- **Wrong methods of gathering data.** An inadequate method of capturing key concepts may lead to errors, for example an improper questionnaire method measuring the level of a patient's happiness with the level of nursing care may lead to exaggerating or not stressing enough the grievances and complaints.
- **An improper research project.** The researcher did not lay out the research structure in a way that would enable answering the research questions with the least number of possible errors.



Types of statistical error

1. **Random error** - usually impacts only small fragments of data, for example the fact that participants of the study provided not really correct and truthful information caused by them being tired whilst the data was being gathered
2. **Systematic error** - occurs when abnormalities are constant and homogeneous. For example, if the scales used to measure the body weight of the participants of the study increased the real result of the measurement of each participant by 1kg, a systematic error will be present in the data regarding body weight.



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- Rigorous research methods try to eliminate or lessen systematic errors, or at least discover their presence in order to take them into account when interpreting the data.
- Scientists implement various strategies in order to overcome errors. One of the methods is the aforementioned triangulation, which means obtaining data from numerous possible sources, or using various methods in order to counteract errors, or identify them.
- Quantitative researchers employ many methods of countering errors, a significant portion of which is based on study control.



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Stages of quantitative research

Stage I - conceptual

1. Formulating and determining the outlines of the problem.
2. A revision of appropriate literature.
3. Determining the clinical field of action.
4. Determining the frames of the project and designing conceptual definitions.
5. Formulating hypotheses.

Stage II - design and planning

1. Selecting the research project.
2. Devising intervention protocols
3. Identifying the population of the study.
4. Creating a project of the sampling plan (sample choice).



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5. Determining the method of measuring variables.
6. Taking into consideration human/animal rights.
7. Finalizing and reviewing the research plan.(a pilot trial / applying for financing to the appropriate institution.

Stage III - Empirical

1. Gathering data.
2. Preparing the data for analysis.

Stage IV. Analytical

1. Analysing the data.
2. Interpreting the results.

Stage V. Dissemination of research results,

1. Issuing the results to all who are interested in them (a report of the course of the study/ scientific articles.
2. Using the research results in practice.



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Stages of qualitative research

1. Identifying the research problem.
2. Performing a review of literature.
3. Selecting the place for the study and obtaining access.
4. Conducting the qualitative research.
5. Disseminating the research results.

The criteria of assessment of the quality of the research

QUANTITATIVE RESEARCH

- **Credibility** - the accuracy and integrity of the data obtained as a result of the study
- **Statistical reliability** reflects the probability that the same results can be obtained using a new study group (sample), that is the results are a precise description of a broader group and do not only pertain to the de-facto studied specific set of participants
- **Authenticity** pertaining to the reliability of the evidence obtained through the study - whether it is internally cohesive, convincing, and has a solid basis in the current knowledge (verifying the measurement methods, and the influence of the independent variable on the dependent variable - the cause-effect relationship, and the functional relationship).
- **Triangulation** consists in using many sources or references in order to infer the truth (determining alternative operational definitions of the dependent variable and comparing the research results in relation to all of them, their integrity, and repeatability)

QUALITATIVE RESEARCH

- **Confidence** (building confidence in the gathered data) -
- **Reliability** pertains to evidence which is cohesive and stable.
- **Verifiability** is similar to objectivity, and reflects the level to which the research results are the outcome of the characteristics of the study participants and the study context rather than the various types of interferences dependent on the scientists or other factors.
- **Reliability**, as a very important aspect of confidence, reflects the level of confidence in the authenticity of the data, incited by the research methods, as well as the methods of data interpretation.
- In a qualitative research, **triangulation** may mean attempts to understand the complexity of a given not-well-studied phenomenon through using various methods of obtaining data, which, however, aim to uncover the truth (for example, interviewing the study participants, as well as observing their behaviour under natural conditions).



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Determining a population. Selecting a sample for the research

Establishment of terminology

- **A statistical population** is a set of any entities (for example, people, units, objects, enterprises, or geographical regions) which have at least one common attribute, and are different when considered from other points of view (Starzyńska, 2016).

Example:

Professionally active nurses - a statistical population.

Common attribute - the rights to perform in a profession, and currently performing that profession.

The differentiating attribute- the type of school they graduated from and the level of education, seniority, age, place of work, and/or the place of residence



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Criteria for selecting a sample (statistical population)

Determining it when considering the following:

- **typology**, for example all types of hospitals are represented in the sample,
- **The distribution of certain attributes**, for example in regard to the gender, the proportion of men and women in the sample is close to the proportion of men and women in the general population,
- **Statistical dependence** - the relationship between certain variables in the sample is to a given accuracy the same as in the general populace

If the above criteria are met, one can state that the sample is representative.

A. Non-random sampling - the researcher has the necessary information about the general population, that is its structure, the values of the variables, the configuration of the variables, and is the one to include each individual element to the sample. This way, the created sample may accurately reflect the general population and be its precise model.

Warning! Non-random sampling when not having enough information about the general population can lead to not ensuring its full representativeness, that is why it is used when random sampling is not possible or its costs would be too high and not economically justifiable.

Techniques:

- a) Sampling typical units,
- b) Proportional sampling,
- c) Sampling through elimination

Sampling

B. Random sampling - consists in having each element of a population have the same probability of being chosen into the sample. It's used in order to counteract interfering factors. The structure of such a group is similar to the general population. If the sample is random, then the degree of representativeness grows with increasing the size of the sample.

Techniques:

- a) **Independent sampling (return)** - after each sampling, an entity goes back to the general population (N-count is constant),
- b) **Dependent sampling (non-return)** - after each sampling, the chosen element does not participate in the next

WARNING! If the population is numerous, it doesn't matter which technique one chooses, however, if it is small, dependent sampling should be chosen.

Techniques:

a) Stratified sampling - the population should be divided into sub-groups in terms of a specific attribute, before the sampling starts, and then in each group a separate dependent or independent sampling is done.

b) Simple sampling - using random tables or in a systematic way, for example randomization

A numerous group - *random numbers tables* helpful (they contain sequences of randomly entered natural numbers, which determine entering a sample into the group).

Not so numerous group - *drawing pieces of paper* with numbers, names of groups or facilities.

A list of facilities is available - sample *using an N/n step*,

1st step $1000/100 = 10$

2nd step - randomly choosing a natural number N_0 lower than the step of the sampling, for example 7, and then the following enter the group: 7; 7+10; 7+20; 7+30, and so on...



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Systematic random sampling consists in randomly choosing just a single statistical unit which belongs to a given population, and the remaining ones are selected in such a way that there are the same number of units between the randomly chosen one and the next.

Warning! Random sampling does not guarantee obtaining a sample identical to the general population, but allows to calculate the probability to what degree the sample is close to the general population. That is why it is said that random sampling ensures representativeness of the sample within the confines of the so-called random error. That is why the results of sampling can be generalised onto the general population only in approximation and with a specific risk of error.



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