PHASES OF RESEARCH PROCESS

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If one would like to have truthful information on world around, on nature, on human being, he/she have to look for convincing data. Collecting such data is process complicated, and complex and due to this very difficult. For layman or even for medical student at the beginning of her/his professional career can seem this statement hypertrophic, overshot, and not very probable. Their view will change quickly when they are involved in research (even very simple). It is generally accepted that reliable information on human health state are necessary for prevention of disease development and disease treatment. **Only way how to obtain such information is research in which are used scientific methods and it is done by qualified and experienced scientists.**

Generally, **research is understood as systematic, controlled, empiric and critical investigation of hypothetic statements on supposed relationships among phenomenon**. It is a process in which **thinking is dominant**. Characteristic features of research are:

– Systematic solving of scientific problems

– using scientific methods

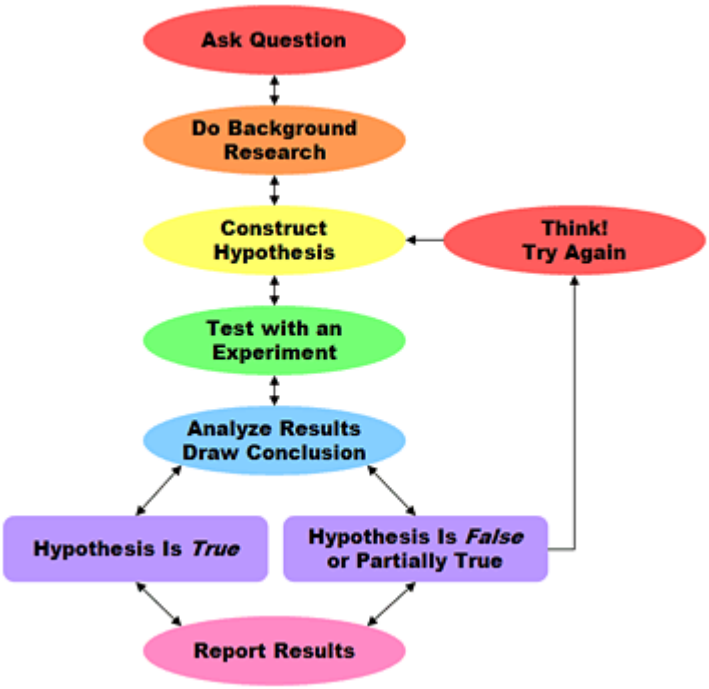
– System of interconnecting phases and steps

The research process should be understood as one of ongoing planning, searching, discovery, reflection, synthesis, revision, and learning, as shown in the figure 1 below:

Fig. 1 The inspiration for the Research process model image above was the reflective model from: Edwards S. Bruce C. Reflective Internet Searching, an Action Research Model." In:

Action Learning, Action Research and Process Management, Theory, Practice Praxis. Action Research Unit, Griffith University. 5th World Congress of Action Learning, Action Research and Process Management, University of Ballarat, Victoria, September, pp. 141-152. Cited in: Bruce, Christine Susan. "Information Literacy as a Catalyst for Educational Change: A Background Paper." U.S. National Commission on Libraries and Information Science, 2006. <http://www.nclis.gov/libinter/infolitconf&meet/papers/bruce-fullpaper.pdf>.

As showed above research is composed of a certain **phases and steps**. Step order may vary depending on the subject matter and researcher (Wikipedia, 2009). Taking into account different guidelines one can distinguishes different number of phases/steps in research process. Frequently, those phases/steps can have different names, e.g. Olin and Uris Library offer seven steps in doing research (Kaste and Hartman, 1998). Other guidelines recommend from 10 to 23 steps in running research (AAMC, 2001; Basic Steps in the Research Process. Cambridge Rindge and Latin School CRLS Research Guide, http://crlsresearchguide.org ; Olin Levi Warner Research helping the torch of knowledge. Library of Congress Thomas Jefferson Building, Washington D.C.) It seems rational to reduce the number of research phases to five and each of phases can be divided to certain steps.



The following five phases outline a simple and effective strategy for conducting effective research:

I. **The conceptual phase**
II. **Phase of construction of research design**
III. **Empiric phase**
IV. **Analytic phase**
V. **Disseminative phase**

Phases of research process are most frequently used in the presented order. But in other guidelines you can find another order of phases and steps. This variability can be ascribed to flexibility of the formal rules of research process which should be adapted to a studied subject and to the special conditions under which the research is done.

I. Phase of conception

According Brink at al. (2006) this phase of research involves activities with a strong conceptual element. „Conceptualisation refers to the process of developing refining abstract ideas. During this phase, the researcher categorises and labels his/her impressions. Thus, the **activities include thinking, rethinking, theorising, making decision, and reviewing ideas** with colleagues, research partners or mentors/supervisors. The researcher also needs **to draw on the skills and abilities of creativity, analysis and insight, as well as on the firm grounding of existing research on the topic of interest“**.

Phase of conception is the first phase of original research. In this phase are created **content and structure** of the planned research. **Creation of conception of new research project is structured process.** It can be divided into 4 steps as follows:

1) **Formulation of research problem or research questions, set bounds of them, determine the purpose of the study**
2) **Searching and review the literature relating to the regarding research problem and develop a framework**
3) **Development of the theoretical construction of the future research**
4) **Creation of hypothesis which should be verified/phalsified in future research**

1) Formulation of research problem and set bounds of it

The first step of the research work is **to state the scientific problem**. It is important to clearly state what your problem is to avoid any confusion later. **Formulation of scientific problem is frequently recognized as the most difficult and the most important part of research project**. Precisely it was expressed by A. Einstein (paraphrase): „If I have one hour for solving the problem on which my life depends, than I will devote 40 minutes to study the problem, 15 minutes to analyse the ways how to solve it, and only 5 minutes to solve it“. Scientific problem is frequently stated in form of **a question**.

If formulation of scientific problem is so difficult and important who than is qualified to do this job? There is consent that it should be a person(s):

– with large and high quality of knowledge in the respective field,
– with high creativity, able to think independently, large knowledge in culture and history, with ability to persist in research despite of serious problems,
– with non-conventional thinking,
– able to doubt on recent valid truth (dogmas),
– able to formulate and publicly present his/her own doubts,
– with appropriate dose of curiosity,
– able to resist to fashionable hypotheses and theories,
– able to preserve independent thinking in the „sphere" of strong scientific and/or political personalities,

– with high grade of perseverance in looking for scientific problem and its definition, able to look at scientific problem from different points of view,
– possessing excellent memory and appropriate dose of emotionality.

How the really important scientific problem can be discovered and defined?

According the definition **the problem** is something you'd like to know more about, **a question** you'd like to answer. Such questions can come from many different sources: from lectures or textbooks, from an experiment you have just made (that raised another questions), from articles you've read in scientific journals or even newspapers and magazines. To **identify a scientific problem**, than, you can find sources that relate to your topic and look to see what problems are raised in your search. Write down the problems that you find. **Choose one that would be interesting to solve and that is feasible for you to solve** (NC State University, 2004). Discovery of good scientific problem can't be planned. It will emerge or not! It can emerge at any time of day and night, at any situations (sometimes very peculiar) without any identifiable dependence to previous study or research work. Despite of the mentioned uncertainties some situations and activities are more frequently recognized as the source of new ideas, new scientific problems. These are:

– sometimes it can be **mere chance or it can be a result of observation an accidentally Recorded phenomenon during research,**
– it can be discovered **by systematic study of the subject**, and the problem emerge as a gap

– it can be identified **during study of different sources of technical literature** as cotroversies related to some facts, functions, and so on.

At the beginning the scientific problem is usually not well defined. There are not clear limit, its bounds are not set well. So, you may need to narrow it, to identify a more specific topic within the broader one (refinement of research question/problem). This can make it easier to work with. **To set up the boundaries of scientific problem is very important step in preparation of future research**. To fulfil this aim one have to:

- think about possible causes of observed new, up to now unknown phenomenon,
- create of hypothesis,
- think on whether defined scientific problem is solvable,
- think about methods suitable for solving the defined scientific problem.

How the research problem is formulated?

At the beginning there is e.g. accidental observation of phenomenon which we are not able to explain. Thank to our curiosity **we will start with looking for explanation**. We formulate questions-why and how the phenomenon originated. There is a lot of uncertainties and only small amount of certainties at the beginning. The consideration on possible cause(s) of the phenomenon is formulated. These considerations we discussed with co-workers, we are looking for answers in literature, and we consider personal experience of other researcher. **If we are not able to find convincing explanation than we formulate primary research problem**. Subsequently, we consider its solubility. If it seems soluble than what we are thinking on possible kinds of method which can be used for this purpose. If it seem not soluble than it is necessary to go back and start to think about the research problem once again.

Looking for, to define, to set the boundaries of scientific problem are the steps which are essential for quality of created scientific problem. On the above mentioned steps depends also the importance of the results which will be obtained by solving the problem, and how these results will influence branches of science, the science as whole and whole society. From this point of view we can distinguish **so called „serious“research problems** solving which brink a very new knowledge in the field. Their importance is manifested by awarding their authors by Nobel Prize, e.g. in 2008 yr discovery of papiloma virus was done, in 1962 it was discovery of DNA structure, in 2009 it was discovered structure of ribosome and function of telomere and enzyme telomerase. These discoveries are really serious ones. Discovery and solving of **„less important“ research problem** brink, however, very useful

results, too. It can be, e.g. discovery of new important law in scientific branch or introduction of new discoveries to medical practice. Such discoveries are awarded, too but by another type of prizes.

2. Searching and review the literature relating to the regarding research problem and development a framework

It is regular rule that research projects begins with conducting literature, which means **to identify related research**, **to set the current research project within a conceptual and theoretical context**. When conducting the literature review it's important to **concentrate on the scientific literature**, start with **the most valuable research journals** in your topical area, use a blind or juried review system on the research journals and **do the review early in the research process.** In the literature review you might be able to find a study that is quite similar to the one you are thinking of doing and the literature review will help you to **find and select appropriate measurement instruments** and it will also **help you to anticipate common problems** in your research context and will **help you to avoid common traps.**

The aims of literature review are **to get an insight and to get a view work of others**, and there are some requirements needed to be fulfilled to be an effective review analyser. One of the requirements is to compare different authors views on an issue and in the same time **put those with similar conclusions in groups, note the disagreement areas and conclude by summarising what the literature says**. The best way to do a literature review is **to use library resources**. And to write a good literature review you have to have an ability **to show why your research should be carried out, and why you did choose certain theories to work w**ith. **And how your work already adds to research carried out**. When reading you need to decide which ideas or information are important so you could emphasis them, and you should look at conclusions, theories, arguments that underline the work and look for similarities and differences with closely related work. And when writing you should compare and show relationships between the work already done by for example another researcher and compare it with another research, and see differences and decide who is most convincing.

So, using other words, the aim of this step is **to find the current information related to the recognized research problem**. Not to be confused with a book review, **a literature review surveys scholarly articles, books and other sources (e.g. dissertations, conference proceedings) relevant to a particular issue, area of research**, **or theory, providing a description**, **summary, and critical evaluation of each work**. The purpose of a literature

review is than to offer an overview of significant literature published on a topic (Concordia University Libraries, 2006).

By study of literature we would like to find the answers to following questions:

– did anybody else formulate the same research problem in the past?

– did anybody else solve the same or similar problem in the past?

– are the results of the previous solving acceptable for us or not?

Result of the searching literature is than **more precisely defined research problem** or the **recent research problem is rejected** because it was successfully solved in the past. More details on the topic you will find in the specific chapter devoted to searching for literal information.

3) Development of the theoretical construction of the future research

Before the real research will start it is necessary to create its **theoretical construction** (abstract construction, virtual model). **The main aim of this step is thinking on the content of presumed research, on its timing (date of beginning, duration of individual stages, duration whole research, date of supposed finish), on its structure (division to stages, phases), on conditions which should be created for successful run of research (persons, money, material, place).** This step give a chance to researcher to think about each detail related to presumed research, to find out very early „weak links of chain" in the planned research, to think on alternative ways in research protocol if some non assumed condition will influence the research process. **Creation of good virtual model of the future research will save the time, money and decrease probability of stressful situations during running research**.

For creation theoretical construction of presumed research are necessary some conditions:

– the research problem should be clearly defined

– the technical, financial and personal conditions are potentially available

– the social, legal and ethical views are known and are consistent with current state (institutional) law and ethical rules and regulations

– the main aims of research are well defined

The important result of this step is clear framework of the way by which the research problem will be solved.

4) Formulation of hypothesis

A stabile step in research is **formulation of a research question. A research question is a statement that identifies the phenomenon to be studied**. A well-thought-out and focused research question **leads directly into your hypotheses**. What predictions would you make about the phenomenon you are examining? This will be the foundation of your application. **Hypotheses are more specific predictions about the nature and direction of the relationship between two variables**. For example, "Those researchers who utilize an online grant writing tutorial will have higher priority scores on their next grant application than those who do not." Such hypothesis can be than verified or phalsified. It is desirable to create **strong hypothesis**. What are the characteristic features of such hypothesis? It should:

– give insight into a research question,

– be testable and measurable by the proposed experiments,

– spring logically from the experience of the staff

Normally, no more than three primary hypotheses should be proposed for a research study. A proposal that is hypothesis-driven is more likely to be funded than a "fishing expedition" or a primarily descriptive study (The Research Assistant, 2003). **Hypothesis is the result of researcher's creativity**. It is a rational assumption on the possible cause(s) of the observed phenomenon. Hypothesis is a source of questions focused to the core of the research problem. Answers to the questions may support (verify) or reject (phalsify) formulated hypothesis. **But we have to realise that** r**esearch process can never completely verify or phalsify the studied hypothesis, it can be done with certain probability, only**. Researcher who has not any doubts on his own research results is not real researcher.

II. Phase of construction of research design

The aim of this phase of research is **to prepare general plan of real research**. According the UCLA Department of Education (Phil Ender, 1998) this phase is composed of following parts:

1) Identification of variables

– dependent variables (responses, outcome, or criterion variables)

– independent variables (explanatory or predictor variables)

– control variables

– intervening variables

2) Construction of operational definitions for variables

3) Selection of design for data analysis

In the process of the design creation should be involved **following steps**:

a) selection of patients, animals, other objects used for research to solve the defined scientific problem (representative sample should be created)

b) selection the methods which are planned to be used in proposed research

c) Selection of technology

d) protocol of research should be constructed

e) the control methods should be stated: to control whether the research procedures are correct or not

f) creation of pilot study

g) to define the statistical methods used for evaluation of the obtained results

h) to define the financial, material and personal needs to secure success in the research

Creation of research design can be expressed by other words. E.g. it seems suitable if we are able **to define key elements of the respective research procedure**. What key elements are?

- description and size of all experimental/research and control groups, as applicable
- a step-by-step list of everything you must do to curry out your research. Think about all the steps that you will need to go through to complete your research, and record exactly what will need to be done in each step
- the research procedure must tell how you will change your one and only independent variable and how you will measure that change
- the research procedure must explain how you will measure the resulting change in the dependent variable(s)
- if applicable, the research procedure should explain how the controlled variables will be maintained at a constant value
- the research procedure should specify how many times you intend to repeat your research (or its parts), so that you can verify that your results are really reproducible
- a good research procedure enables someone else to duplicate your experiment/clinical study/other type of research, exactly!

You have to be aware **where will you conduct your experiment**. You may need a lot of room for your experiment or you may not be able to move your experiment around from place to place. If you are working with human or animal subjects, you may need a location that is quiet or defined by another way. You will need to think about these limitations before you start your research/experiment so you can find a location in advance that will meet your needs.

a) Selection of research objects

As a research object can serve **genes, chromosomes, individual cells, tissue cultures, animals, persons, populations, and technologic devices** (computers, different kinds of models, computer networks and others).

If human being is to be the research object the **inclusion and exclusion criteria** should be defined first, e.g. health state, type of disease, age - children, adults (age span) size of group(s), different age groups, control group, gender, selected group, patients with special kind of disease, and others.

If animals are planned to be a research object than **inclusion and exclusion criteria** should be defined first, too, e.g. species, age, gender, health state, knock-out or knock-in animals, specific pathogen free (SPF) or not SPF, with modelled disease, anesthetised, non-anesthetised and so on.

Research can be rarely realized in whole population. **A population - primary sample** is any entire collection of people, animals, plants or things from which we may collect data. It is the entire group we are interested in, which we wish to describe or draw conclusions about. In order to make any generalisations about a population, **a sample**, that is meant **to be representative of the population - selected sample**, is often studied. For each population there are many possible selected samples. A sample statistic gives information about a corresponding population parameter. For example, the sample mean for a set of data would give information about the overall population mean. It is important that the **investigator carefully and completely defines the population before collecting the sample**, **including a description of the members to be included** (Easton and McColl, www.stats.gla.ac.uk/steps/.../basic_definitions.html)

b) Selection of research methods

Researchers have long debated the relative value of qualitative and quantitative inquiry (Patton, 1990). Phenomenological inquiry, **or qualitative research**, **uses a**

naturalistic approach that seeks to understand phenomena in context-specific settings. Logical positivism, or **quantitative research**, **uses experimental methods and quantitative measures** to test hypothetical generalizations. Each represents a fundamentally different inquiry paradigm, and researcher actions are based on the underlying assumptions of each paradigm.

There are several considerations when deciding to adopt **a qualitative research methodology**. Strauss and Corbin (1990) claim that **qualitative methods can be used** to better understand any phenomenon about which little is yet known. They can also be used to gain new perspectives on things about which much is already known, or to gain more in-depth information that may be difficult to convey quantitatively. **Thus, qualitative methods are appropriate in situations where one needs to first identify the variables that might later be tested quantitatively**, **or where the researcher has determined that quantitative measures cannot adequately describe or interpret a situation**. Research problems tend to be framed as open-ended questions that will support discovery of new information.

Quantitative research refers to the systematic empirical investigation of **quantitative properties** and **phenomena** and their **relationships**. The objective of quantitative research is **to develop and employ mathematical models, theories and/or hypotheses pertaining to phenomena.** The process of **measurement is central** to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships.

From another point of view we can distinguish **physiological, biochemical, genetic, mathematical, physical, invasive, and non-invasive** and other types of research methods.

c) Selection of technology

It is necessary to define/to grow serious **what kind of devices have to be used, what technical parameters they should have** if we would like to be sure that recorded/gathering parameters are really objective and exact. In this process can be helpful if researcher has convincing information on usefulness of the chosen methods in previous similar research done by other researcher. Than he/she can **re-use exactly the same methods** in own research. Validity of obtained results will be high **if research technology in both researches is the same quality**. If necessary some **adaptation/modification** in re-used method can be done but it should be described precisely. More complicated is situation, when researcher has to develop **new/original method** for solving the research problem. In this case **validity of new method should be first proven,** and than it can be used in research. This method should be

described in full details, its usage clearly justified, and obtained results should undergo to critic analysis.

d) Protocol of research

What is a protocol of research? It is **precise description of all steps done during research**. **All steps are settled on time axis**. The research protocol forms **an essential part of a research.** As your research ideas develop into a workable study a written protocol **will help to formalise your ideas and gain feedback** from others through peer review. A well written protocol **is also necessary for your applications to funding bodies and ethics and research governance committees.** The protocol can also act **as a manual for members of the research team** to ensure they adhere to the methods outlined. As your study gets underway, the protocol can then be used **to monitor the study's progress and evaluate its outcomes.** The protocol encourages the reader to think about the study rigorously and provides communication between all of the people involved.

Structure of research protocol can be as it is described in: Writing a research protocol. In: http://www.psy.herts.ac.uk/hrdsu/docs/Writing-research-protocol.doc.)

Title: The title clearly identifies the study and may contain a brief description of the study design and objectives.

Investigators/Researchers including contact addresses: Everyone who has made a valuable contribution to the study should be named and their contact details given

Abstract/Summary: Summarise the aims or objectives of the study and give a brief outline of the design and methods.

Background/Introduction: The introduction should outline the background to the research, including a critical review of the current knowledge or literature, including published and unpublished work in the area. Any gaps in the evidence should be identified as should the potential value of furthering knowledge in this field, such as theoretical or clinical applications of the study outcomes. If applicable, the research hypothesis should also be included in this section, with an explanation of the reasons for undertaking the work.

Aims and Objectives: Outline concise and precise objectives that should follow on from the hypothesis.

Study design and methods:

- **Study design.** What study design is most appropriate to answer your particular research? question
- **Setting.** Where will the research take place? Your study may take place in a number of

different sites or you may be visiting patients in their homes. You need to address any practical issues involved, such as safety procedures when doing home visits.

- **Subjects/Patients.** Detailed information regarding your subjects should be given. For example, describe the study population, including a rationale of why they were chosen. Describe the methods by which subjects will be identified and recruited and what inclusion and exclusion criteria will be used. You will need to justify your sample size and state whether sample size calculations have been used. It may also be necessary to describe the criteria for participation or completion of the study, participant retention strategies and withdrawal criteria.
- **Randomisation methods.** Some research strategies, such as case control studies or randomised control studies, require a random allocation of patients to the different experimental groups or interventions. You will need to explain what randomisation methods you will use.
- **Methods of assessment or measurement.** What data will be collected and why. For example how will you measure your participants quality of life, what instruments will you use and are they the most appropriate? If you are using any equipment it should be clearly described.
- **Outcome measures/objectives.** The measurement outcomes used to support or reject the hypotheses can be stated and separated into primary and secondary outcomes. For example, primary outcomes or endpoints are most important to your hypothesis, there may be only 1 or 2. Secondary outcomes may provide some support to the hypothesis, but without the primary outcomes they could not confirm the hypothesis.
- **Interventions (if applicable).** Not all studies will involve any interventions, but if yours does a description of the study intervention should be provided. If you are giving a treatment or investigation, the dose, timing, method of providing, administering and receiving the treatment should be detailed. All necessary safeguards and potential risks should be made clear, including the methods by which intervention will be monitored.

Data collection, management and analysis:

Explain how the data will be collected and managed and who will have access to it. The method of the data analysis should also be specified and may include the following points:

- method of data entry
- plan of analysis, including assumptions of analysis
- data analysis package

- presentation of demographic and outcome data summaries
- planned presentation of the data, i.e. graphs, tables, figures

Study administration and ethical issues:

- outline the methods by which the patient/subject's interests will be safeguarded. For example, the process of risk limitation, how you will maintain confidentiality or anonymise patient's data and how you will monitor any adverse side effects
- state whether there has been user involvement in design of the study.
- if applicable, state whether you have followed the Clinical trials directive, and you have Regulatory authority approval
- you should also state who will provide indemnity in case of harm to your participants through negligence?
- if applicable, the protocol should clearly state who is sponsoring the research study and what interest they have in its outcome. It is also necessary to state whether the sponsors are to provide indemnity in the case of negligent harm to participants.

Resource requirements:

The resource implications to the host organisation and any other involved departments should be defined in this section. In addition you must outline the timetable/schedule of the research and all costs.

Study plan:

You may wish to include a study plan, showing a brief summary or flow chart of the order, site and timing of all study procedures. It may also be useful to include consent forms and participant information in appendices.

Supervision:

Where applicable, the protocol should name the individual(s) who will supervise the research project and the intended arrangements for the supervision.

Dissemination and outcome:

How will the study's findings be made available? State whether you intend to publish or present the findings. Any implications for future practice and patient care should also be suggested.

Control mechanisms

Control mechanisms should be stated for each research. The reason for it is that each activity of person, including researcher, can be burden by mistakes. They may be of subjective or/and objective origin. Mistakes can be involved in planning and in running of research. Some mistakes can't be eliminated, so, it will be necessary to take them into account when the results will be interpreted. Other group of mistakes can be identified and excluded during preparation of research, or can be eliminated during pilot study, and some even at the preparation of results for publication. First control mechanism is **autocontrol.** Author(s) of research project should repeatedly check individual phases and steps of research project. As a second form of control mechanism is recommended **peer-review** done by co-workers from the same lab, another labs or external expert. Very efficient control form of project quality is carrying out the **pilot study.** This step can find and eliminate conceptual, formal and technological weak places in the project.

f) Pilot study

The research is ready for implement the plan. However, where possible, he/she should first carry out a pilot study, which is a small-scale version of „dummy run"of the major study. Unforseen problem can arise in the course of a project. By doing a pilot study, the researcher can recognise and address some of the problems by obtaining information for improving the project, making adjustments to the research instruments, to research plan, to protocol, to time schedule, and to other parts of research project, or re-assessing the feasibility of the study (Brink at al, 2006).

g) Select design for data analysis

In this step researcher should consult with specialist on statistics. The aim of this consultation is to choose correct statistic methods for evaluation of results obtained in respective research. Researcher should present to statistician clearly all goals of research. By co-operation both the high probability does exist that appropriate statistic method will be chosen and research result will be evaluated correctly.

h) Determination of other condition necessary for success of research

Research funding is the most important condition for researcher. Without financial support it is not possible to do valuable research. This is the reason why many senior researchers spend more than a trivial amount of their time applying for grants for research funds. These grants are necessary not only for researchers to carry out their research, but also

as a source of merit. Other inevitable conditions for research work are: appropriate material, places for research with appropriate equipment, well prepared and motivated personal, and other, and sometimes very special conditions.

III. Empiric phase

In this phase, **the researcher implements all the plans that he/she made in First phase, step 3, to collect the data**. In many studies empirical phase is the most time-consuming part of the investigation. The amount of time spent, however, varies from study to study. So, we can say that empiric phase is composed of the following activities:

- To do all activities related **to gaining scientific results, to sort them, and to evaluate them**
- its first step can be pilot study (to tune the research project)

For the gaining of valid results it is necessary to fulfil some **essential conditions**, e.g.

– well prepared research team – researcher should be skilled in using research methods
– researchers should be manually and mentally skilled, experienced
– specification of environmental condition for curry out the research should be present
– to use relevant and sensitive enough methods, technologies
– precisely fulfil protocol of experiment or clinical study
– minimize possibility of subjective negative influence on production data
– minimize of negative influence of environment to research

The result of this phase is production of data in two main forms:

- **qualitative form**
- **quantitative form: in analogue form**
  in digital form

The way by which is research conducted and the level of organization used for data collection can importantly influence the amount and quality of obtained results

Examples of qualitative data:

– pain, fatigue, dyspnoea, feeling of cold or heat, paresthesias, dizziness, fear, anger, apathy and others similar

Examples of quantitative data:

– biochemical, electrophysiological, ultrasound, x-ray and other data obtained by measuring and recording different kinds of parameters in clinical or experimental

study

It was mentioned above that for production of objective scientific information is necessary to use methods which will guarantee the highest degree of production unbiased results. This is important mainly:

- when on the same research participate more researchers from the same research team
- when the respective research is conducted at more laboratories or in different hospitals in one or more countries (multicentre studies)
- that researchers are well informed on what parameters should be observed and recorded
- to stress that terminology of recorded parameters have to be well defined and all researchers should understand their meaning

Key elements of the experimental procedure

If you use experiment as a method in your research than you should be familiar with its key elements. Here they are:

- description and size of all experimental and control groups, as applicable
- a step-by-step list of everything you must do to perform your experiment. Think about all the steps that you will need to go through to complete your experiment, and record exactly what will need to be done in each step
- the experimental procedure must tell how you will change your one and only independent variable and how you will measure that change
- the experimental procedure must explain how you will measure the resulting change in the dependent variable or variables
- if applicable, the experimental procedure should explain how the controlled variables will be maintained at a constant value
- the experimental procedure should specify how many times you intend to repeat your experiment, so that you can verify that your results are reproducible
- a good experimental procedure enables someone else to duplicate your experiment exactly!

Another questions related to experiment should be taken into account, e.g. where will you conduct your experiment? You may need a lot of room for you experiment or you may

not be able to move your experiment around from place to place. If you are working with human or animal subjects, you may need a location that is quiet. You will need to think about these limitations before you start your experiment so you can find a location in advance that will meet your needs.

The researcher normally collects the data according to the pre-established plan, and collects actual information, that is data, usage the instrument that has been developed and tested in the pilot study (Brink at al, 2006). Rational system for collection of data should involve:

- organisation of the collection, namely:
  - timing of data collection – continuously, at the end of research, day time, part of the year....
  - quantity and quality of persons responsible for data collection – to prepare clear instruction, setting the educational requirements....
  - material requirements – e.g. the method used for archivation of data
- preparation of data for next evaluation
- control of data completeness and correctness
  - whether the data are classified according their characteristic signs correctly
  - elimination of incorrect data
  - supplement missing data
- control of representativeness of the data
  - elimination of incorrectly chosen patients, animals and their data
- to code of data – give numbers instead of words to each data
  – to transform the data for computer elaboration

IV. Analytic phase

Once the data collection and surveying activities have yielded sufficient and relevant data, it is time **to systematically organize the data so that it can be interpreted and analyzed by researcher**. As it is written by Brink et al. (2006) the data collected in the empirical phase are not reported in „raw“form. **They must be summarised and subjected to various types of analysis and interpretation**. Before starting to analyse or process the data, the **researcher must examine them for completeness and accuracy**. Incomplete and inaccurate data can be discarded. Than data are **organised in an orderly**, **coherent fashion**

so that he/she can discern patterns and relationships. So, the content of this phase can be summarising in the following processes:

- analysis of quantitative data and/or analysis of qualitative data
- analysis of the data by statistical methods
- interpretation of the results

The steps used in analytic phase of research are:

a) systemic processing of data: e.g. classification of data according characteristic properties/features

b) correlation: looking for relationships among the two or more recorded data (parameters)

When we are looking for possible correlations our attention should be focused to:

– if qualitative and quantitative correlations do exist

– find simple correlation – between two parameters

– find complex correlation – among many parameter

– if there is linear correlation – manifested as straight line

– if there is non-linear correlation – manifested as variously shaped curve

– if there is direct correlation – positive

– if there is indirect correlation – negative

c) comparison: comparison of the result obtained in our research with data obtained in similar research done by other researchers

d) induction – looking for generalised conclusion on the base of limited amount of results

In order to be meaningful, the **results obtained from data analysis require interpretation**. Interpretation reports to the researcher's act of **drawing conclusions and making sense of the results.** As part of the process he/she asks him-/herself these questions:

- what does the result imply?
- what did we actually learn from the data?
- what do the findings mean for others? What is the value of the study for them?
- what recommendation can we make for further research? (Brink et al., 2006)

V. Disseminative phase

The job is not completed, however, until the researcher communicates the result of the study to others who may find it useful. So, dissemination means process when results of the research are presented or published as:

– final research report from research project

– lectures and/or posters at the congresses and conferences

– papers in journals

– using the result in clinical practice

It is very important to know where is suitable to present your research results! Another chapter in this manual is devoted to explanation of the content of this phase.

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