Outline:

What is research?

Science developes through some systematic observation, measurementation and experimentation, and interpretation procedure called "research". Thus, research is the most important, if not the only tool for development of science.

There are various definitions depending on the approach. Some definitions are:

- The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions. (Concise Oxford English Dictionary)

- Scientific investigation that is performed in order to discover new information or to develop or improve products and technology (Academic Press Dictionary of Science Technology)

- Scientific or scholarly inquiry or investigation and the proper communication of the findings.

- The process of searching for, in a broader sense, general answers in any field of study or, in a limited fashion, a solution to just one particular problem.

- A systematic, controlled, empirical, rigorous, and precise method used to obtain solutions or to discover and interpret new information

- A careful, systematic, patient study and investigation in some field of knowledge, undertaken to establish facts or principles.

- A structured inquiry that utilizes acceptable scientific methodology to solve problems, and creates new knowledge that is generally acceptable.

- A systematic investigation to find answers to a problem.

- …..

One can feel closer to one of these (or other) definitions depending on his/her standpoint. For most people all the definitions are valid, and they are actually different ways of expressing the same think.

Differences sometimes may seem to be significant among social and physical scientists; but that is not acceptable as the main features of science are universal. The differences are not in definition but in the tools and methodologies used in research for social and physical sciences.

Characteristics of research.

(This part has been prepared mainly from: Ranjit Kumar, **Research Methodology, Sage Publications,** London, 1999)

To qualify as research, the research process must have certain characteristics:

- ***Research is controlled.***

  There may be several interacting factors/parameters that effect a particular scientific event. For example the size (volume, V) of a balloon directly depends on temperature (T) and the amount of gas (n) in it. It also depends on the pressure (P) in an inverse manner. So in science we say that the volume, V, of a gas is a function of n, P and T. Most scientific events are more complicated, i.e., they have more interacting parameters.

  It is usually very difficult to measure/observe the effect of all parameters at the same time. Therefore, researchers usually observe the effect of one variable while keeping the other parameters constant. Then they do the same thing to the other variables one-by-one.

  This may require some assumptions (like assuming the slightly varying room temperature as a "constant temperature") or using some external control mechanisms (like using constant temperature baths).

  This may require rigorous laboratory conditions, or expensive equipment in physical sciences.

  Life is very complicated, and it has thousands of variables. Attempting to control all of these variables is merely impossible. However, that does not mean that we can't do "controlled variable research" in social sciences. This problem is mainly overcome by a careful and systematic "sampling" and "classification". For example they measure the impacts of some variables by using different age groups, different ethnicities, different gender etc.

- ***Research is rigorous (strictly accurate).***

  A researcher must ensure that the procedures followed to find answers to questions are relevant, appropriate, and justified.

  Again the degree of strictness varies markedly between the physical and the social sciences, and even within the social sciences.

- ***Research is systematic.***

  The procedures adopted to undertake an investigation follow a certain logical sequence. Carefully designed research plans and procedures are a must in research. Randomness, or lack of direction is not tolerated.

- ***Research outcomes are valid and verifiable.***

  What you find, or what you conclude after research should be correct, and repeatable, or reproducible (by you or by others).

- ***Research is empirical.***

  Any conclusions drawn are based upon solid evidence gathered from real measurements or, real experiences, or observations. This a must in scientific research.

- ***Research is "critical".***

  Procedures and methods used in research have critical importance in research. Therefore, they should be well-devised and leave no possible margin for error, and free from any drawbacks.

- ***Research is innovative.***

  Research does not develop from randomly generated ideas but all involve "innovation" (plus some "luck")

- ***Research is usually expensive.***

  Researchers have high salaries by themselves. The equipments and the tools they use are also expensive. The most challenging difficulty is to find financial resources to build an up-to-date laboratory.

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Types of research.

Research often said to have two types: "pure research" and "applied research".

Especially social scientists have other classification types of research. These include:

- ***Pure research (also called basic research).***

  Pure research has the purpose of expanding the knowledge base and, thus, its future potential in a given area.

  "Pure research involves developing and testing theories and hypothesis that are intellectually challenging to the researcher but may or may not have practical application at the present time or in the future. Thus such work often involves the testing of hypothesis containing very abstract and specialized concepts"

  This type of research is usually done in the universities. Its impact on daily life applications is not immediate.

  Basic research is usually funded by governments and universities.

- ***Applied research.***

  Applied research is fundamentally motivated by the development of a new product or a next-generation product.

  Almost all research done in the private research institutions are "applied research". Therefore, applied research is usually funded by industry.

  Universities are also deeply involved in applied research. Most of the research in engineering and social sciences is applied.

There are other classifications of research emerging from different perspectives like the goals and objectives, funds available, type of information sought, application of the research outcomes, the nature of the research topic etc. Some of them are:

- ***Descriptive research*** – attempts to systematically describe a situation, problem, phenomenon, service, or a program. Example: living conditions of a community

- ***Exploratory research*** (also known as feasibility study, or pilot study) – investigation of the possibilities of undertaking a particular research study. Example: a small scale study undertaken to decide if it is worth carrying out a detailed investigation.

- ***Correlational research –*** attempts to discover or establish the existence of a relationship / association / interdependence between two or more aspects of a situation. Example: "What is the relationship between technology and employment? "

- ***Explanatory research –*** attempts to clarify why and how there is a relationship between two aspects of a situation or phenomenon. Example: "why a stressful living results with heart attacks?"

Depending on the type of information sought, or how the variables are measured, or how the information analyzed the research can be classified as "qualitative" or quantitative"

- ***Quantitative research –*** This involves measurements or analysis using quantitative variables. It densely involves measurement of magnitudes. Example: "What is the effect of pressure on volume?"

- ***Qualitative research*** **-** This involves measurements or analysis using nominal (existing in name only) or ordinal (relating to order in a series) variables. Example: description of an observation.

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Outcomes of research.

(from The research student's guide to success, P. Cryer, Open University Press, Buckingham, 2000)

Research problems can be in terms of "to produce", "to design", or "to develop" something, and research outcomes can be in terms of having "produced", "designed" or "developed" something.

Outcomes of research is also linked with the originality in research which is another topic covered in this lecture.

The following are examples from a wide range of possibilities:

- ***A new or improved product.***

  There is a hazy borderline between a new product and an improvement on an existing one. For the purpose of developing a research problem, the distinction is unimportant.

- ***A new theory or a reinterpretation of an existing theory.***

  Developing new theories like relativity theory of Einstein, or the evolution theory of Darwin is difficult, hence, very rare at graduate level research.

  Instead, most graduate level researches fall into the class of reinterpretation of existing theories.

- ***A new or improved research tool or technique.***

  It may be a new measuring device, a new software to undertake certain tasks, a piece of equipment to identify a disease, a new microscope to explore nanoparticles etc.

- ***A new or improved model or perspective***

  It is looking and interpreting the knowledge through a fresh way.

  A good example is thinking about time as a fourth dimension, which can be traveled through, like the other dimensions (length, breadth and height)

- ***An in-depth study.***

Sometimes one may find the opportunity to study something that has never been studied before. A good example is studying the moons of Jupiter through enormous amount of data supplied by the Galileo probe.

- ***An exploration of a topic area or field.***

  It is especially a good starting point when the main features of the search topic is unknown.

- ***A critical analysis.***

  A good example is the analysis of the use of safe nuclear energy to replace fossil energy resources at the edge of global warming.

- ***A portfolio of work based on research.***

  Professionals in many fields can produce these.

- ***A fact or conclusion, or a collection of facts or conclusions.***

  It is a particularly common outcome of research in all fields.

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Recent trends in research

- ***interdisciplinarity….***

  Team work from different disciplines

- ***International collaboration***

  Teamwork from different countries & networking

Originality in research

(mainly from "The research student's guide to success", P. Cryer, Open University Press, Buckingham, 2000)

Originality is a "must" in research. It is a high-profile requirement. You should develop the necessary skills to recognize "what is original?" and implement it into your work. It may need a considerable incubation period for the creative skills to function effectively in development of originality in your research. You need to appreciate the scope and potential of originality.

One or more of the following requirements must be fulfilled in your research in order to claim for originality.

- ***Originality in tools, techniques and procedures.***

  Your research methodology may include fairly standard tools, techniques and procedures in the field of study. But if you use them in new untested ways, this would justify a claim of originality.

Or if you develop new procedures, tools and techniques for a specific purpose, this too will also justify a claim for originality. For example, development of a new "controlled release" system of an existing drug is original.

- ***Originality in exploring the unknown.***

  Your studies are said to be original if you are conducting a major investigation of something which has never been investigated before such as a recently discovered catalyst for fuel cells, a new medicine for cancer treatment etc.

  Recognizing the "original" in some fields or in some types of research is easy (obvious), but in many fields of study it can be elusive (difficult to understand and grasp). There may always be an uncertainty on "what is original". Originality may be unpredictable. You must learn to live with a certain amount of uncertainty. It may be difficult to live with uncertainty, but, on the other and it is the fuel of curiosity and creativity.

- ***Originality in exploring the unanticipated (exploring the sidetracks).***

  Some researchers may prefer to abandon the planned research and travel through the sidetracks. It is exciting since it is full of unknowns, and you may open alternative ways forward which have never previously been studied.

  They can, on the other hand, equally turn out to be dead ends which consume time and effort fruitlessly. Focusing on the originally aimed goals always increases the chance of being more fruitful in research through a calculated level of originality.

- ***Originality in use of data.***

  The more data you collect, the higher the chance for a more original work. You may find out, after careful post processing, or analysis of your data, that some of the data collected might be an indication of an original behavior, or side-product, or unseen benefit

- ***Originality in outcomes.***

  Potato was an unknown (original) to British people until Sir Walter Raleigh brought it to England from America. It was known in America perhaps for centuries but original, unique in England. Some discoveries may be like this. A discovery may not be new to a discipline, but it may turn out to be important in another discipline. For example, aspirin can no longer be an excitement source for chemists since they know every detail about it. However, its use in the treatment of hearth diseases may be new and create enough excitement among medical doctors.

- ***Originality in the byproducts.***

  There are almost always byproducts during any research: Perhaps development of a certain piece of equipment, or some secondary findings in literature. These can be moved into the mainstream of the research, and focused on or developed further. When the thesis is written, the research problem, theme or focus merely needs to be reformulated to reflect the new nature of the work.

- ***Originality in the experience.***

  Students who stay the course with their research should be able to tease out something worthwhile from an academic or scholarly standpoint. Improvement of the creative thinking skills may help.

- ***Originality as "potentially publishable".***

Most research especially at PhD level ought to be able to generate at least one, and probably several, journal articles in "peer-reviewed" ("refereed") journals. A research article should provide an acceptable claim for originality.

- ***Facts, ideas and originality.***

  Professor Michael Talbot of the University of Liverpool described the nature of originality in one of lectures to graduate students as:

  If we accept that there are two ingredients, facts and ideas, and that both may be either 'new' (never before presented to the world) or 'old' (familiar from earlier commentary), four possible combinations arise:

  1. New facts + New ideas
  2. New facts + Old ideas
  3. Old facts + New ideas
  4. Old facts + Old ideas.

  Combinations 1–3 all lead to originality. Only combination 4 is guaranteed to miss out on originality. Between them, combinations 1, 2 and 3 cater for an enormous variety of scholarly talents, temperaments and opportunities.

- ***The balance between originality and conformity.***

  It may be difficult for the examiners (jury members in your thesis defense or referees during the publication process) to appreciate the originality of your research if it is too original. The rejection rate of highly original articles is known to be unexpectedly high since the referees are seemingly not ready yet to understand and comprehend the shocking new findings. Therefore, unless your supervisor is not a world-wide famous scientist, be a little cautious on pushing the level of originality too far.

- ***The ownership of original work.***

  Original work play important role in career advancement of both students and supervisors. Therefore, such so-called "intellectual properties" need to be respected and protected.

  Usually they are protected with "copyright laws". The academic world developed very serious codes of research ethics to keep their members at a continuous honorable and trustable state. Any violation of these codes, or ethical rules may result with very severe sanctions like exclusion from the academic world.

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Research environment and a brief introduction to academic carrier.

Research is conducted mainly in the following institutions all-over the world.

- ***Government or private research institutions (institutes).***

  Governments usually have such institutions for specific purposes. For example Marmara Araştırma Enstitüsü (Marmara Research Institute) of TUBITAK (Turkish Council of Scientific Research) serves to the scientific development of Turkey by leading innovative research projects. Max Planck Institute in Germany, Weizmann Institute in Israel are good examples to such institutes.

On the other hand there are several profit based private research institutes in developed countries. They develop and convey research projects for special needs of industry. They usually hire staff with academic background. People just do research there; they don't have obligations to teach or serve to the community.

- ***Research and development (R&D) units of big companies.***

  Big companies in industry, like Nikon, Sony, DuPont, Google, IBM, or Intel have their own R&D sections, and they develop their products in their own laboratories.

  Having an R&D section is not easy. The cost is very high. Most of the cost is due to the necessity to hire staff with relatively high salaries. For example, approximately 2000 qualified engineers work in the laboratories of Panasonic.

  Due to this enormous costs of R&D units, some small scale companies form consortiums. Companies that are producing the same kind of product come together and share the cost of research by founding, and maintaining a common R&D company. This R&D company develops the technology. This technology, then, is owned by all member companies of the consortium. Each company, then, refines the technology proven, and gives the final shape of the product depending on their competitive claims.

  As an example, take detergents industry. The basic ingredients of all detergents are more or less the same. The basic formulation can be described by a common R&D unit, and then each company do slight variations like adding blue balls (whiteners), or enzymes for lower temperature washing, or they may decrease or increase the amount of the major ingredients to cope with the washing habits of their target customers and they market their own products with different brand names etc.

  The nature of the industry is very competitive, therefore, their needs for research is immediate. They can not withstand long research projects in order not to risk their competitive position in the market. Therefore, the length of industrial research projects often do not exceed 6 months.

- ***Research in the universities.***

  Faculty members (academic staff holding a PhD degree) in universities have three basic duties:

  - Teaching
  - Being an active researcher
  - Service to the university and community.

  The amount of time allocated to perform these duties varies from university to university. There are mainly two types of universities:

  - Research universities
  - Teaching universities

  The weekly teaching hours of the staff is arranged accordingly. Faculty members in research universities teach around 6 hours a week whereas in teaching universities it may go up to 14-16 hours a week.

  Whatever the type of the university, faculty members should be involved in research in order to survive as an academician.

  Therefore, "research" is a must for being an academician.

Graduate students is an integral part of research in universities. They join one or more of the faculty members, and develop their research skills by being actively involved in their projects.

Master degree programs intend to develop basic research skills. It is instruction based meaning a high degree of supervisor guidance in carrying out the research.

PhD studies require more elaborate research, higher degree of originality, and more independence (from supervisor) in carrying out the procedures. It prepares the students to the academic carrier such that they can become independent researchers once they graduate.

Undergraduate programs are under the umbrella of faculties, or deans whereas the graduate programs are governed by special administrative units like "graduate schools" in most American universities, or institutes of graduate studies as it is the case in Turkish universities. The reason for such a difference is to allow researchers of a university to be able to do "multidisciplinary / interdisciplinary research". Although such multidisciplinary programs are not common yet, there is an increasing trend for opening such programs.

Although the graduate education is governed by the Institutes, the research is conducted in the academic departments or research centers. The choice of supervisor, courses to be completed, formation of the thesis defense jury etc all require the consent of the department head.

Research in Universities is a relatively longer process. (2 years in MS and 4 years in PhD). This usually doesn't cope with the immediate demands of industry. But still university-industry collaboration is becoming more and more common. This helps the researchers to find financial support for their projects.

Features of Academic Life.

You will find yourself in a working environment of high intellectual capacity. You will be working with professors, associate professors etc. This initially may seem to be scary, or boring. But, as you proceed, you will enjoy it.

It has its own advantages one can find in any other working environment.

First of all relatively high level of "freedom" in academic life is the most distinctive property. An academician is free to determine his/her own research topics, or determine what and how to teach in the classroom. This does not mean that this so-called "academic freedom" has no limits. There are missions, goals, policies, rules and regulations of each university, and whatever you do should satisfy these limitations.

Academicians represent the most respected, and the most trusted segment of the society. This results with a difficult-to-describe sort of self-satisfaction, and helps to improve your personality and self-confidence.

Academic assessments, peer reviews (e.g., in thesis defense) or promotions are based on well defined rules and regulations. Therefore all decisions regarding your carrier will be fair enough at the utmost level. Thus the reflection of personal conflicts is minimal in academic life.

There is no other job to satisfy the curiosities of a human being like an academic job. You have the opportunity to learn a new fact every day, or being challenged with new questions and answers during research.

Not only your research skills improve in an academic medium, but also your communication skills, information technology skills, language skills, organizational skills, thinking skills, social or interpersonal relation skills improve as you proceed in an academic carrier.

The skills developed and knowledge gained are universal, therefore academicians can work in almost all countries. Thus, job opportunities are always more promising than other professions.

Academicians often get high salaries. They also have fringe benefits like having the chance of seeing different countries through participation in conferences, or by joining joint research projects of other academicians abroad etc. They can also improve their salaries by being involved in externally funded research projects or consultancies.

Publishing the results of your research is a must in academic carrier. By being a productive research author, you can be invited to be involved in some very honorable and prestigious events like being a referee or editor in a journal, a plenary speaker in a conferences, policy developer in governmental issues etc.

Job of the academicians is not monotonous; it does not include routine works. They deal with diverse studies or works; therefore academic life is not boring.

Academicians usually govern themselves. They contribute to the decisions through academic boards, or committees. They do not do "instruction based" work. They very very infrequently take orders from the department head.