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Methodology of scientific research

(*Lecture notes*)

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TOPIC 1
INTRODUCTION. SCIENCE IS A PRODUCTIVE FORCE OF SOCIETY'S DEVELOPMENT

1. The essence of science, historical aspects of development

On the simplest level, science is knowledge of the world of nature. There are many regularities in nature that humankind has had to recognize for survival since the emergence of *Homo sapiens* as a species. The Sun and the Moon periodically repeat their movements. Some motions, like the daily "motion" of the Sun, are simple to observe, while others, like the annual "motion" of the Sun, are far more difficult. Both motions correlate with important terrestrial events. Day and night provide the basic rhythm of human existence. The seasons determine the migration of animals upon which humans have depended for millennia for survival. With the invention of agriculture, the seasons became even more crucial, for failure to recognize the proper time for planting could lead to starvation. Science defined simply as knowledge of natural processes is universal among humankind, and it has existed since the dawn of human existence.

The mere recognition of regularities does not exhaust the full meaning of science, however. In the first place, regularities may be simply constructs of the human mind. Humans leap to conclusions. The mind cannot tolerate chaos, so it constructs regularities even when none objectively exists. Thus, for example, one of the astronomical "laws" of the Middle Ages was that the appearance of comets presaged a great upheaval, as the Norman Conquest of Britain followed the comet of 1066. True regularities must be established by detached examination of data. Science, therefore, must employ a certain degree of skepticism to prevent premature generalization.

Regularities, even when expressed mathematically as laws of nature, are not fully satisfactory to everyone. Some insist that genuine understanding demands explanations of the causes of the laws, but it is in the realm of causation that there is the greatest disagreement. Modern quantum mechanics, for example, has given up the quest for causation and today rests only on mathematical description. Modern biology, on the other hand, thrives on causal chains that permit the understanding of physiological and evolutionary processes in terms of the physical activities of entities such as molecules, cells, and organisms. But even if causation and explanation are admitted as necessary, there is little agreement on the kinds of causes that are permissible, or possible, in science. If the history of science is to make any sense whatsoever, it is necessary to deal with the past on its own terms, and the fact is that for most of the history of science natural philosophers appealed to causes that would be summarily rejected by modern scientists. Spiritual and divine forces were accepted as both real and necessary until the end of the 18th century and, in areas such as biology, deep into the 19th century as well.

Certain conventions governed the appeal to God or the gods or to spirits. Gods and spirits, it was held, could not be completely arbitrary in their actions. Otherwise, the proper response would be propitiation, not rational investigation.

But, since the deity or deities were themselves rational or bound by rational principles, it was possible for humans to uncover the rational order of the world. Faith in the ultimate rationality of the creator or governor of the world could actually stimulate original scientific work. Kepler's laws, Newton's absolute space, and Einstein's rejection of the probabilistic nature of quantum mechanics were all based on theological, not scientific, assumptions. For sensitive interpreters of phenomena, the ultimate intelligibility of nature has seemed to demand some rational guiding spirit. A notable expression of this idea is Einstein's statemet that the wonder is not that humankind comprehends the world but that the world is comprehensible.

Science, then, is to be considered in this article as knowledge of natural regularities that is subjected to some degree of skeptical rigour and explained by rational causes. One final caution is necessary. Nature is known only through the senses, of which sight, touch, and hearing are the dominant ones, and the human notion of reality is skewed toward the objects of these senses. The invention of such instruments as the telescope, the microscope, and the Geiger counter enabled an ever-increasing range of phenomena within the scope of the senses. Thus, scientific knowledge of the world is only partial, and the progress of science follows the ability of humans to make phenomena perceivable.

This article provides a broad survey of the development of science as a way of studying and understanding the world, from the primitive stage of noting important regularities in nature to the epochal revolution in the notion of what constitutes reality that occurred in 20th-century physics. More-detailed treatments of the histories of specific sciences, including developments of the later 20th and early 21st centuries, may be found in the articles biology; Earth science; and physical science.

2. The concept of science as a sphere of human activity in the knowledge of the objective world

Science, as it has been defined above, made its appearance before writing. It is necessary, therefore, to infer from archaeological remains what was the content of that science. From cave paintings and from apparently regular scratches on bone and reindeer horn, it is known that prehistoric humans were close observers of nature who carefully tracked the seasons and times of the year. About 2500 BCE there was a sudden burst of activity that seems to have had clear scientific importance. Great Britain and northwestern Europe contain large stone structures from that era, the most famous of which is Stonehenge on the Salisbury Plain in England, that are remarkable from a scientific point of view. Not only do they reveal technical and social skills of a high order – it was no mean feat to move such enormous blocks of stone considerable distances and place them in position – but the basicconception of Stonehenge and the other megalithic structures also seems to combine religious and astronomical purposes. Their layouts suggest a degree of mathematical sophistication that was first suspected only in the mid-20th century. Stonehenge is a circle, but some of the other megalithic structures are eggshaped and, apparently, constructed on mathematical principles that require at least practical knowledge of the Pythagorean theorem that the square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides. This theorem, or at least the Pythagorean numbers that can be generated by it, seems to have been known throughout Asia, the Middle East, and Neolithic Europe two millennia before the birth of Pythagoras.

This combination of religion and astronomy was fundamental to the early history of science. It is found in Mesopotamia, Egypt, China (although to a much lesser extent than elsewhere), Central America, and India. The spectacle of the heavens, with the clearly discernible order and regularity of most heavenly bodies highlighted by extraordinary events such as comets and novae and the peculiar motions of the planets, obviously was an irresistible intellectual puzzle to early humankind. In its search for order and regularity, the human mind could do no better than to seize upon the heavens as the paradigm of certain knowledge. Astronomy was to remain the queen of the sciences (welded solidly to theology) for the next 4,000 years.

Science, in its mature form, developed only in the West. But it is instructive to survey the protoscience that appeared in other areas, especially in light of the fact that until quite recently this knowledge was often, as in China, far superior to Western science.

China

As has already been noted, astronomy seems everywhere to have been the first science to emerge. Its intimate relation to religion gave it a ritual dimension that then stimulated the growth of mathematics. Chinese savants, for example, early devised a calendar and methods of plotting the positions of stellar constellations. Since changes in the heavens presaged important changes on the Earth (for the Chinese considered the universe to be a vast organism in which all elements were connected), astronomy and astrology were incorporated into the system of government from the very dawn of the Chinese state in the 2nd millennium BCE. As the Chinese bureaucracy developed, an accurate calendar became absolutely necessary to the maintenance of legitimacy and order. The result was a system of astronomical observations and records unparalleled elsewhere, thanks to which there are, today, star catalogs and observations of eclipses and novae that go back for millennia.

In other sciences too the overriding emphasis was on practicality, for the Chinese, almost alone among ancient peoples, did not fill the cosmos with gods and demons whose arbitrary wills determined events. Order was inherent and, therefore, expected. It was for humans to detect and describe this order and to profit from it. Chemistry (or, rather, alchemy), medicine, geology,geography, and technology were all encouraged by the state and flourished. Practical knowledge of a high order permitted the Chinese to deal with practical problems for centuries on a level not attained in the West until the Renaissance.

India

Astronomy was studied in India for calendrical purposes to set the times for both practical and religious tasks. Primary emphasis was placed on solar and lunar motions, the fixed stars serving as a background against which these luminaries moved. Indian mathematics seems to have been quite advanced, with particular sophistication in geometrical and algebraic techniques. This latter branch was undoubtedly stimulated by the flexibility of the Indian system of numeration that later was to come into the West as the Hindu-Arabic numerals.

America

Quite independently of China, India, and the other civilizations of Europe and Asia, the Maya of Central America, building upon older cultures, created a complex society in which astronomy and astrology played important roles. Determination of the calendar, again, had both practical and religious significance. Solar and lunar eclipses were important, as was the position of the bright planet Venus. No sophisticated mathematics are known to have been associated with this astronomy, but the Mayan calendar was both ingenious and the result of careful observation.

The Middle East

In the cradles of Western civilization in Egypt and Mesopotamia, there were two rather different situations. In Egypt there was an assumption of cosmic order guaranteed by a host of benevolentgods. Unlike China, whose rugged geography often produced disastrous floods, earthquakes, and violent storms that destroyed crops, Egypt was surpassingly placid and delightful. Egyptians found it difficult to believe that all ended with death. Enormous intellectual and physical labour, therefore, was devoted to preserving life after death. Both Egyptian theology and the pyramids are testaments to this preoccupation. All of the important questions were answered by religion, so the Egyptians did not concern themselves overmuch with speculations about the universe. The stars and the planets had astrological significance in that the major heavenly bodies were assumed to “rule” the land when they were in the ascendant (from the succession of these “rules” came the seven-day week, after the five planets and the Sun and the Moon), but astronomy was largely limited to the calendrical calculations necessary to predict the annual life-giving flood of the Nile. None of this required much mathematics, and there was, consequently, little of any importance.

Mesopotamia was more like China. The life of the land depended upon the two great rivers, the Tigris and the Euphrates, as that of China depended upon the Huang He (Yellow River) and the Yangtze(Chang Jiang). The land was harsh and made habitable only by extensive damming and irrigation works. Storms, insects, floods, and invaders made life insecure. To create a stable society required both great technological skill, for the creation of hydraulic works, and the ability to hold off the forces of disruption. These latter were early identified with powerful and arbitrary gods who dominated Mesopotamian theology. The cities of the plain were centred on temples run by a priestly caste whose functions included the planning of major public works, like canals, dams, and irrigation systems, the allocation of the resources of the city to its members, and the averting of a divine wrath that could wipe everything out.

Mathematics and astronomy thrived under these conditions. The number system, probably drawn from the system of weights and coinage, was based on

60 (it was in ancient Mesopotamia that the system of degrees, minutes, and seconds developed) and was adapted to a practical arithmetic. The heavens were the abode of the gods, and because heavenly phenomena were thought to presage terrestrial disasters, they were carefully observed and recorded. Out of these practices grew, first, a highly developed mathematics that went far beyond the requirements of daily business, and then, some centuries later, a descriptive astronomy that was the most sophisticated of the ancient world until the Greeks took it over and perfected it.

Nothing is known of the motives of these early mathematicians for carrying their studies beyond the calculations of volumes of dirt to be removed from canals and the provisions necessary for work parties. It may have been simply intellectual play –the role of playfulness in the history of science should not be underestimated – that led them onward to abstract algebra. There are texts from about 1700 BCE that are remarkable for their mathematical suppleness. Babylonian mathematicians knew the Pythagorean relationship well and used it constantly. They could solve simple quadratic equations and could even solve problems in compound interest involving exponents. From about a millennium later there are texts that utilize these skills to provide a very elaborate mathematical description of astronomical phenomena.

Although China and Mesopotamia provide examples of exact observation and precise description of nature, what is missing is explanation in the scientific mode. The Chinese assumed a cosmic order that was vaguely founded on the balance of opposite forces (yin–yang) and the harmony of the five elements (water, wood, metal, fire, and earth). Why this harmony obtained was not discussed. Similarly, the Egyptians found the world harmonious because the gods willed it so. For Babylonians and other Mesopotamian cultures, order existed only so long as all-powerful and capricious gods supported it. In all these societies, humans could describe nature and use it, but to understand it was the function of religion and magic, not reason. It was the Greeks who first sought to go beyond description and to arrive at reasonable explanations of natural phenomena that did not involve the arbitrary will of the gods. Gods might still play a role, as indeed they did for centuries to come, but even the gods were subject to rational laws.

Greek science

There seems to be no good reason why the Hellenes, clustered in isolated city-states in a relatively poor and backward land, should have struck out into intellectual regions that were only dimly perceived, if at all, by the splendid civilizations of the Yangtze, Tigris and Euphrates, and Nile valleys. There were many differences between ancient Greece and the other civilizations, but perhaps the most significant was religion. What is striking about Greek religion, in contrast to the religions of Mesopotamia and Egypt, is its puerility. Both of the great river civilizations evolved complex theologies that served to answer most, if not all, of the large questions about humankind's place and destiny. Greek religion did not. It was, in fact, little more than a collection of folk tales, more appropriate to the campfire than to the temple. Perhaps this was the result of the collapse of an earlier Greek civilization, the Mycenaean, toward the end of the 2nd millennium BCE, when the Dark Age descended upon Greece and lasted for three centuries. All that was preserved were stories of gods and men, passed along by poets, that dimly reflected Mycenaean values and events. Such were the great poems of Homer, the *Iliad* and the *Odyssey*, in which heroes and gods mingled freely with one another. Indeed, they mingled too freely, for the gods appear in these tales as little more than immortal adolescents whose tricks and feats, when compared with the concerns of a Marduk or Jehovah, are infantile. There really was no Greek theology in the sense that theology provides acoherent and profound explanation of the workings of both the cosmos and the human heart. Hence, there were no easy answers to inquiring Greek minds. The result was that ample room was left for a more penetrating and ultimately more satisfying mode of inquiry. Thus were philosophy and its oldest offspring, science, born.

The first natural philosopher, according to Hellenic tradition, was Thales of Miletus, who flourished in the 6th century BCE. We know of him only through later accounts, for nothing he wrote has survived. He is supposed to have predicted a solar eclipse in 585 BCE and to have invented the formal study of geometry in his demonstration of the bisecting of a circle by its diameter. Most importantly, he tried to explain all observed natural phenomena in terms of the changes of a single substance, water, which can be seen to exist in solid, liquid, and gaseous states. What for Thales guaranteed the regularity and rationality of the world was the innate divinity in all things that directed them to their divinely appointed ends. From these ideas there emerged two characteristics of classical Greek science. The first was the view of the universe as an ordered structure (the Greek *kósmos* means “order”). The second was the conviction that this order was not that of a mechanical contrivance but that of an organism: all parts of the universe had purposes in the overall scheme of things, and objects moved naturally toward the ends they were fated to serve. This motion toward ends is calledteleology and, with but few exceptions, it permeated Greek as well as much later science.

Thales inadvertently made one other fundamental contribution to the development of natural science. By naming a specific substance as the basic element of all matter, Thales opened himself tocriticism, which was not long in coming. His own disciple, Anaximander, was quick to argue that water could not be the basic substance. His argument was simple: water, if it is anything, is essentially wet; nothing can be its own contradiction. Hence, if Thales were correct, the opposite of wet could not exist in a substance, and that would preclude all of the dry things that are observed in the world. Therefore, Thales was wrong. Here was the birth of the critical tradition that is fundamental to the advance of science.

Thales’ conjectures set off an intellectual explosion, most of which was devoted to increasingly refined criticisms of his doctrine of fundamental matter. Various single substances were proposed and then rejected, ultimately in favour of a multiplicity of elements that could account for such opposite qualities as wet and dry, hot and cold. Two centuries after Thales, most natural philosophers accepted a doctrine of four elements: earth (cold and dry), fire (hot and dry), water (cold and wet), and air (hot and wet). All bodies were made from these four.

The presence of the elements only guaranteed the presence of their qualities in various proportions. What was not accounted for was the form these elements took, which served to differentiate natural objects from one another. The problem of form was first attacked systematically by the philosopher and cult leader Pythagoras in the 6th century BCE. Legend has it that Pythagoras became convinced of the primacy of number when he realized that the musical notes produced by a monochord were in simple ratio to the length of the string. Qualities (tones) were reduced to quantities (numbers inintegral ratios). Thus was born mathematical physics, for this discovery provided the essential bridge between the world of physical experience and that of numerical relationships. Number provided the answer to the question of the origin of forms and qualities.

Medieval European science

Medieval Christendom confronted Islam chiefly in military crusades, in Spain and the Holy Land, and in theology. From this confrontation came the restoration of ancient learning to the West. The Reconquista in Spain gradually pushed the Moors south from the Pyrenees, and among the treasures left behind were Arabic translations of Greek works of science and philosophy. In 1085 the city ofToledo, with one of the finest libraries in Islam, fell to the Christians. Among the occupiers were Christian monks who quickly began the process of translating ancient works into Latin. By the end of the 12th century much of the ancient heritage was again available to the Latin West.

The medieval world was caricatured by thinkers of the 18th-century Enlightenment as a period of darkness, superstition, and hostility to science and learning. On the contrary, it was one of great technological vitality. The advances that were made may appear today as trifling, but that is because they were so fundamental. They included the horseshoe and the horse collar, without which horsepower cannot be efficiently exploited. The invention of the crank, the brace and bit, the wheelbarrow, and the flying buttress made possible the great Gothic cathedrals. Improvements in the gear trains of waterwheels and the development of windmills harnessed these sources of power with great efficiency. Mechanical ingenuity, building on experience with mills and power wheels, culminated in the 14th century in the mechanical clock, which not only set a new standard of chronometrical accuracy but also provided philosophers with a new metaphor for nature itself.

An equal amount of energy was devoted to achieving a scientific understanding of nature, but it is essential to understand to what use medieval thinkers put this kind of knowledge. As the fertility of the technology shows, medieval Europeans had no deep prejudices against utilitarian knowledge. But the areas in which scientific knowledge could find useful expression were few. Instead, science was viewed chiefly as a means of understanding God’s creation and, thereby, the Godhead itself. The best example of this attitude is found in the medieval study of optics. Light, as Genesis makes clear, was among the first creations of God. The 12th–13th-century cleric-scholar Robert Grosseteste saw in light the first creative impulse. As light spread, it created both space and matter, and, in its reflection from the outermost circle of the cosmos, it gradually solidified into the heavenly spheres. To understand the laws of the propagation of light was to understand, in some slight way, the nature of the creation.

In the course of studying light, particular problems were isolated and attacked. What, for example, is the rainbow? It is impossible to get close enough to a rainbow to see clearly what is going on, for as the observer moves, so too does the rainbow. It does seem to depend upon the presence of raindrops, so medieval investigators sought to bring the rainbow down from the skies into their studies. Insight into the nature of the rainbow could be achieved by simulating the conditions under which rainbows occur. For raindrops the investigators substituted hollow glass balls filled with water, so that the rainbow could be studied at leisure. Valid conclusions about rainbows could then be drawn by assuming the validity of the analogy between raindrops and water-filled globes. This involved theimplicit assumptions that nature was simple (i.e., governed by a few general laws) and that similar effects had similar causes. Such a nature was what could be expected of a rational, benevolent deity. Hence, the assumption could be persuasively adopted.

Medieval philosophers were not content, as the above example shows, to repeat what the ancients had said. They subjected ancient texts to close critical scrutiny. Usually, the intensity of the criticism was directly proportional to the theological significance of the problem involved. Such was the case with motion. Medieval philosophers examined all aspects of motion with great care, for the nature of motion had important theological implications. Thomas Aquinas used Aristotle's dictum, that everything that moves is moved by something else, to show that God must exist, for otherwise the existence of any motion would imply an infinite regression of prior causal motions.

It should be clear that there was no conscious conflict between science and religion in the Middle Ages. As Aquinas pointed out, God was the author of both the book of Scripture and the book of nature. The guide to nature was reason, the faculty that was the image of God in which humankind was made. Scripture was direct revelation, although it needed interpretation, for there were passages that were obscure or difficult. The two books, having the same author, could not contradict each other. For the short term, science and revelation marched hand in hand. Aquinas carefully wove knowledge of nature into his theology, as in his proof from motion of the existence of God. But if his scientific concepts of motion should ever be challenged, there would necessarily be a theological challenge as well. By working science into the very fabric of his theology, he virtually guaranteed that someday there would be conflict. Theologians would side with theology and scientists with science, to create a breach that neither particularly desired.

The glory of medieval science was its integration of science, philosophy, and theology into a magnificent and comprehensible whole. It can be best contemplated in the greatest of all medieval poems, Dante's *Divine Comedy*. Here was an essentially Aristotelian cosmos, finite and easily understood, over which God, his Son, and his saints reigned. Humanity and Earth occupied the centre, as befitted their centrality in God's plan. The nine circles of hell were populated by humans whose exercise of their free will had led to their damnation. Purgatory contained lesser sinners still capable of salvation. The heavenly spheres were populated by the saved and the saintly. The naturalhierarchy gave way to the spiritual hierarchy as one ascended toward the throne of God. Such a hierarchy was reflected in the social and political institutions of medieval Europe, and God, the supreme monarch, ruled his creation with justice and love. All fit together in a grand cosmic scheme, one not to be abandoned lightly.

The Rise Of Modern Science. The authority of phenomena

Even as Dante was writing his great work, deep forces were threatening the unitary cosmos he celebrated. The pace of technological innovation began to quicken. Particularly in Italy, the political demands of the time gave new importance to technology, and a new profession emerged, that of civil and military engineer. These people faced practical problems that demanded practical solutions.Leonardo da Vinci is certainly the most famous of them, though he was much more as well. A painter of genius, he closely studied human anatomy in order to give verisimilitude to his paintings. As a sculptor, he mastered the difficult techniques of casting metal. As a producer-director of the form of Renaissance dramatic production called the masque, he devised complicated machinery to createspecial effects. But it was as a military engineer that he observed the path of a mortar bomb being lobbed over a city wall and insisted that the projectile did not follow two straight lines – a slanted ascent followed by a vertical drop –as Aristotle had said it must. Leonardo and his colleagues needed to know nature truly; no amount of book learning could substitute for actual experience, nor could books impose their authority upon phenomena. What Aristotle and his commentators asserted as philosophical necessity often did not gibe with what could be seen with one's own eyes. The hold of ancient philosophy was too strong to be broken lightly, but a healthy skepticism began to emerge.

The first really serious blow to the traditional acceptance of ancient authorities was the discovery of the New World at the end of the 15th century. Ptolemy, the great astronomer and geographer, had insisted that only the three continents of Europe, Africa, and Asia could exist, and Christian scholars from St. Augustine on had accepted it, for otherwise men would have to walk upside down at the antipodes. But Ptolemy, St. Augustine, and a host of other authorities were wrong. The dramatic expansion of the known world also served to stimulate the study of mathematics, for wealth and fame awaited those who could turn navigation into a real and trustworthy science.

In large part the Renaissance was a time of feverish intellectual activity devoted to the complete recovery of the ancient heritage. To the Aristotelian texts that had been the foundation of medievalthought were added translations of Plato, with his vision of mathematical harmonies, of Galen, with his experiments in physiology and anatomy, and, perhaps most important of all, of Archimedes, who showed how theoretical physics could be done outside the traditional philosophical framework. The results were subversive.

The search for antiquity turned up a peculiar bundle of manuscripts that added a decisive impulse to the direction in which Renaissance science was moving. These manuscripts were taken to have been written by or to report almost at first hand the activities of the legendary priest, prophet, and sageHermes Trismegistos. Hermes was supposedly a contemporary of Moses, and the Hermetic writingscontained an alternative story of creation that gave humans a far more prominent role than the traditional account. God had made humankind fully in his image: a creator, not just a rational animal. Humans could imitate God by creating. To do so, they must learn nature's secrets, and this could be done only by forcing nature to yield them through the tortures of fire, distillation, and other alchemical manipulations. The reward for success would be eternal life and youth, as well as freedom from want and disease. It was a heady vision, and it gave rise to the notion that, through science and technology, humankind could bend nature to its wishes. This is essentially the modern view of science, and it should be emphasized that it occurs only in Western civilization. It is probably this attitude that permitted the West to surpass the East, after centuries of inferiority, in the exploitation of the physical world.

The Hermetic tradition also had more specific effects. Inspired, as is now known, by late Platonist mysticism, the Hermetic writers had rhapsodized on enlightenment and on the source of light, theSun. Marsilio Ficino, the 15th-century Florentine translator of both Plato and the Hermetic writings, composed a treatise on the Sun that came close to idolatry. A young Polish student visiting Italy at the turn of the 16th century was touched by this current. Back in Poland, he began to work on the problems posed by the Ptolemaic astronomical system. With the blessing of the church, which he served formally as a canon, Nicolaus Copernicus set out to modernize the astronomical apparatus by which the church made such important calculations as the proper dates for Easter and other festivals.

The classic age of science

Mechanics

Just as the *Principia* preceded the *Opticks*, so too did mechanics maintain its priority among the sciences in the 18th century, in the process becoming transformed from a branch of physics into a branch of mathematics. Many physical problems were reduced to mathematical ones that provedamenable to solution by increasingly sophisticated analytical methods. The Swiss Leonhard Eulerwas one of the most fertile and prolific workers in mathematics and mathematical physics. His development of the calculus of variations provided a powerful tool for dealing with highly complex problems. In France, Jean Le Rond d'Alembert and Joseph-Louis Lagrange succeeded in completely mathematizing mechanics, reducing it to an axiomatic system requiring only mathematical manipulation.

The test of Newtonian mechanics was its congruence with physical reality. At the beginning of the 18th century it was put to a rigorous test. Cartesians insisted that the Earth, because it was squeezed at the Equator by the etherial vortex causing gravity, should be somewhat pointed at the poles, a shape rather like that of an American football. Newtonians, arguing that centrifugal force was greatest at the Equator, calculated an oblate sphere that was flattened at the poles and bulged at the Equator. The Newtonians were proved correct after careful measurements of a degree of the meridian were made on expeditions to Lapland

and to Peru. The final touch to the Newtonian edifice was provided by Pierre-Simon, marquis de Laplace, whose masterly *Traité de mécanique céleste*(1798–1827; *Celestial Mechanics*) systematized everything that had been done in celestial mechanicsunder Newton's inspiration. Laplace went beyond Newton by showing that the perturbations of the planetary orbits caused by the interactions of planetary gravitation are in fact periodic and that the solar system is, therefore, stable, requiring no divine intervention.

Chemistry

Although Newton was unable to bring to chemistry the kind of clarification he brought to physics, the*Opticks* did provide a method for the study of chemical phenomena. One of the major advances in chemistry in the 18th century was the discovery of the role of air, and of gases generally, in chemical reactions. This role had been dimly glimpsed in the 17th century, but it was not fully seen until the classic experiments of Joseph Black on *magnesia alba* (basic magnesium carbonate) in the 1750s. By extensive and careful use of the chemical balance, Black showed that an air with specific properties could combine with solid substances like quicklime and could be recovered from them. This discovery served to focus attention on the properties of "air," which was soon found to be a generic, not a specific, name. Chemists discovered a host of specific gases and investigated their various properties: some were flammable, others put out flames; some killed animals, others made them lively. Clearly, gases had a great deal to do with chemistry.

The Newton of chemistry was Antoine-Laurent Lavoisier. In a series of careful balance experiments Lavoisier untangled combustion reactions to show that, in contradiction to established theory, which held that a body gave off the principle of inflammation (called phlogiston) when it burned, combustion actually involves the combination of bodies with a gas that Lavoisier named oxygen. The chemical revolution was as much a revolution in method as in conception. Gravimetric methods made possible precise analysis, and this, Lavoisier insisted, was the central concern of the new chemistry. Only when bodies were analyzed as to their constituent substances was it possible to classify them and their attributes logically and consistently.

The founding of modern biology

The study of living matter lagged far behind physics and chemistry, largely because organisms are so much more complex than inanimate bodies or forces. Harvey had shown that living matter could be studied experimentally, but his achievement stood alone for two centuries. For the time being, most students of living nature had to be content to classify living forms as best they could and to attempt to isolate and study aspects of living systems.

As has been seen, an avalanche of new specimens in both botany and zoology put severe pressure on taxonomy. A giant step forward was taken in the 18th century by the Swedish naturalist Carl von Linné – known by his Latinized name, Linnaeus – who introduced a rational, if somewhat artificial, system of binomial nomenclature. The very artificiality of Linnaeus's system, focusing as it did on only a few key structures, encouraged criticism and attempts at more natural systems. The attention thus called to the organism as a whole reinforced a growing intuition that species are linked in some kind of genetic relationship, an idea first made scientifically explicit by Jean-Baptiste, chevalier de Lamarck.

Problems encountered in cataloging the vast collection of invertebrates at the Museum of Natural History in Paris led Lamarck to suggest that species change through time. This idea was not so revolutionary as it is usually painted, for, although it did upset some Christians who read the book of Genesis literally, naturalists who noted the shading of natural forms one into another had been toying with the notion for some time. Lamarck's system failed to gain general assent largely because it relied upon an antiquated chemistry for its causal agents and appeared to imply a conscious drive to perfection on the part of organisms. It was also opposed by one of the most powerful paleontologists and comparative anatomists of the day, Georges Cuvier, who happened to take Genesis quite literally. In spite of Cuvier's opposition, however, the idea remained alive and was finally elevated to scientific status by the labours of Charles Darwin. Darwin not only amassed a wealth of data supporting the notion of transformation of species, but he also was able to suggest a mechanism by which such evolution could occur without recourse to other than purely natural causes. The mechanism wasnatural selection, according to which minute variations in offspring were either favoured or eliminated in the competition for survival, and it permitted the idea of evolution to be perceived with great clarity. Nature shuffled and sorted its own productions, through processes governed purely by chance, so that those organisms that survived were better adapted to a constantly changingenvironment.

Darwin's *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, published in 1859, brought order to the world of organisms. A similar unification at the microscopic level had been brought about by the cell theory announced byTheodor Schwann and Matthias Schleiden in 1838, whereby cells were held to be the basic units of all living tissues. Improvements in the microscope during the 19th century made it possible gradually to lay bare the basic structures of cells, and rapid progress in biochemistry permitted the intimateprobing of cellular physiology. By the end of the century the general feeling was that physics and chemistry sufficed to describe all vital functions and that living matter, subject to the same laws as inanimate matter, would soon yield up its secrets. This reductionist view was triumphantly illustrated in the work of Jacques Loeb, who showed that so-called instincts in lower animals are nothing more than physicochemical reactions, which he labelled tropisms.

The most dramatic revolution in 19th-century biology was the one created by the germ theory ofdisease, championed by Louis Pasteur in France and Robert Koch in Germany. Through their investigations, bacteria were shown to be the specific causes of many diseases. By means of immunological methods first devised by Pasteur, some of humankind's chief maladies were brought under control.

The 20th-century revolution

By the end of the 19th century, the dream of the mastery of nature for the benefit of humankind, first expressed in all its richness by Sir Francis Bacon, seemed on the verge of realization. Science was moving ahead on all fronts, reducing ignorance and producing new tools for the amelioration of the human condition. A comprehensible, rational view of the world was gradually emerging from laboratories and universities. One savant went so far as to express pity for those who would follow him and his colleagues, for they, he thought, would have nothing more to do than to measure things to the next decimal place.

But this sunny confidence did not last long. One annoying problem was that the radiation emitted by atoms proved increasingly difficult to reduce to known mechanical principles. More importantly, physics found itself relying more and more upon the hypothetical properties of a substance, theether, that stubbornly eluded detection. Within a span of 10 short years, roughly 1895–1905, these and related problems came to a head and wrecked the mechanistic system the 19th century had so laboriously built. The discovery of X rays and radioactivity revealed an unexpected new complexity in the structure of atoms. Max Planck's solution to the problem of thermal radiation introduced a discontinuity into the concept of energy that was inexplicable in terms of classical thermodynamics. Most disturbing of all, the enunciation of the special theory of relativity by Albert Einstein in 1905 not only destroyed the ether and all the physics that depended on it but also redefined physics as the study of relations between observers and events, rather than of the events themselves. What was observed, and therefore what happened, was now said to be a function of the observer's location and motion relative to other events. Absolute space was a fiction. The very foundations of physics threatened to crumble.

This modern revolution in physics has not yet been fully assimilated by historians of science. Suffice it to say that scientists managed to come to terms with all of the upsetting results of early 20th-century physics but in ways that made the new physics utterly different from the old. Mechanical models were no longer acceptable, because there were processes (like light) for which no consistent model could be constructed. No longer could physicists speak with confidence of physical reality, but only of the probability of making certain measurements.

All this being said, there is still no doubt that science in the 20th century worked wonders. The new physics – relativity, quantum mechanics, particle physics – may have outraged common sense, but it enabled physicists to probe to the very limits of physical reality. Their instruments and mathematics permitted modern scientists to manipulate subatomic particles with relative ease, to reconstruct the first moment of creation, and to dimly glimpse the grand structure and ultimate fate of the universe.

The revolution in physics has spilled over in the 21st century into chemistry and biology and has led to hitherto undreamed-of capabilities for the manipulation of atoms and molecules and of cells and their genetic structures. Chemists perform molecular tailoring today as a matter of course, cutting and shaping molecules at will. Genetic engineering and the subsequent development of gene editing made possible active human intervention in the evolutionary process and held out the possibility of tailoring living organisms, including the human organism, to specific tasks. This second scientific revolution may prove to be, for good or ill, one of the most important events in the history of humankind.

3. The process of cognition, its types and structure, the conceptual apparatus, the content and functions of science

Since the Sixteenth National Congress of the Communist Party of China (CPC), the CPC Central Committee with Comrade Hu Jintao as General Secretary has been holding high the great banner of Deng Xiaoping Theory and the important thought of Three Represents, thoroughly implementing the guiding principles set out at the Sixteenth Congress and at the third through fifth plenary sessions of the Sixteenth Central Committee, steadfastly building the Party for the public and running the government for the people, working realistically and pragmatically, and forging ahead resolutely. While promoting all aspects of socialist economic, political, cultural and social development and improving the Party, the Central Committee has been constantly making innovations in the Party's theories. It has formulated a number of major strategic concepts, such as the Scientific Outlook on Development, building a harmonious socialist society, strengthening the Party's governance capacity and advanced nature, making China an innovative country, building a new socialist countryside, instilling in society a socialist concept of honor and disgrace, and taking the path of peaceful development. All these ideas provide the scientific theoretical guidance and powerful ideological guarantees for developing the causes of the Party and the people.

The Scientific Outlook on Development, which puts people first and calls for comprehensive, balanced and sustainable development, is a major strategic concept introduced by the Party after taking into account the overall development of the causes of the Party and the nation in this new stage of the new century. It is a major guiding concept to be adhered to for a long time to come in promoting economic and social development and accelerating socialist modernization.

The profound meaning and basic requirement of the Scientific Outlook on Development are as follows :

- Putting people first means taking their all-round personal development as our goal, planning and promoting development on the basis of their fundamental interests, meeting their ever-growing material and cultural needs, protecting their economic, political and cultural rights and interests, and ensuring that development benefits everyone.
- Comprehensive development is development that takes economic development as the central task and promotes all aspects of economic, political, cultural, and social development to achieve economic growth and all-round social progress.
- Balanced development is development the hat balances urban and rural development, development among regions, economic and social development, development of man and nature, and domestic development and

opening to the outside world, and promotes balance between the productive forces and the relations of production, between the economic base and the superstructure, and among all links and aspects of economic, political, cultural and social development.

- Sustainable development is development that promotes harmony between man and nature and balance between economic development and changes in the population, resources and the environment, keeps to the road of civilized development that leads to increased production, better lives for the people and an excellent ecosystem, and ensures continued development generation after generation.

The most important aspect of the Scientific Outlook on Development is development ; putting people first is its core ; and its basic requirement is comprehensive, balanced and sustainable development. These three aspects are interconnected and form an organic whole whose nature is to achieve rapid and sound economic and social development.

The Outlook is a profound reflection of the Party's new understanding of development issues. It also reflects the new economic, political and cultural situation in the world today and the new requirements for China's economic and social development during this crucial period. The overall objectives and strategic arrangements for the country's economic and social development over the next five years were introduced at the Fifth Plenary Session of the Sixteenth Central Committee, and the Outline of the Eleventh Five-Year Plan for National Economic and Social Development (2006-2010) was approved at the Fourth Session of the Tenth National People's Congress. We must seize opportunities to promote rapid and sound economic and social development, achieve the great objectives set out in the Eleventh Five-Year Plan and lay a solid foundation for building a moderately prosperous society in all respects. The key to achieving this is to firmly establish and comprehensively implement the Scientific Outlook on Development, incorporate the Outlook in the whole course and in every aspect of economic and social development, and get economic and social development to put people first and be comprehensive, balanced and sustainable.

Among all Party members and people across the nation, a widespread consensus has been reached on the Scientific Outlook on Development, and among the international community, the Outlook has attracted a great deal of attention since it was introduced. The cadres and the masses have heartily supported the Outlook, thoroughly studied it, and earnestly worked to put it into practice. This constitutes a powerful driving force advancing the cause of socialism with Chinese characteristics. Comrade Hu Jintao pointed out, “All comrades in the Party must acquire a deep understanding of the great importance of establishing and implementing the Scientific Outlook on Development from the strategic perspective of implementing the important thought of Three Represents and the guiding principles set out at the Sixteenth Congress and the strategic perspective of attaining the great objective of building a moderately prosperous society in all respects. We must unswervingly work to establish and implement the Outlook to better accomplish the historic tasks we are tackling in this new stage of the new century." Arming the thinking of all Party members, especially leading cadres at all levels, with the Outlook, unifying their thinking and deepening consensus among them is a long-term strategic task. We must untiringly study, analyze and publicize the Outlook to gain a profound and thorough understanding of its great significance, profound meaning and basic requirement, understand the Marxist worldview and methodology incorporated in it, and implement it more consciously and firmly, so that it becomes a powerful ideological weapon to guide advancement of the great cause of socialism with Chinese characteristics.

0 I. The scientific outlook on development : an important guiding concept for promoting socialist modernization that must be adhered to for a long time to come0

The Party's formulation of the major strategic concept of the Scientific Outlook on Development was guided by Deng Xiaoping Theory and the important thought of Three Represents and was based on a correct understanding of global development trends, a careful review of China's development experience and a thorough analysis of the nature of the country's current stage of development. The Outlook reflects a deeper understanding of the general laws governing economic and social development, fully embodies the Marxist worldview on and methodology for development, and is a guiding principle for promoting comprehensive socialist economic, political, cultural and social development to be adhered to for a long time to come.

The Scientific Outlook on Development is a continuation and development of the approach to development contained in Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and the important thought of Three Represents.

The Scientific Outlook on Development conforms to the basic tenets of Marxism, is closely tied to the great practice of socialism with Chinese characteristics and incorporates the recent fruits of the progress of human civilization. From the perspective of history and the times, the Outlook further clarifies a series of major issues related to China's socialist development in this new stage of the new century. It is a continuation and development of the approach to development contained in Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and the important thought of Three Represents.

The issue of the development of human society, especially socialist society, is an important component of Marxist theory. Karl Marx and Friedrich Engels believed that the development of human society is a natural historical process, that the development of the productive forces is the ultimate deciding factor in human society's development, that addressing conflicts between the productive forces and the relations of production and between the economic base and the superstructure generates the fundamental force driving social development, that the growth of production must correctly handle relationships among the people, between individuals and society, and between man and nature, and that development of human society would gradually erase the antagonism and bridge the differences between classes, between urban and rural areas, and between those engaged in mental work and those engaged in physical work. This will produce overwhelming material wealth, greatly raise the mental state of the people and allow all individuals to develop freely and comprehensively. Vladimir Lenin stated that after the proletariat seizes state power, its primary and fundamental task is to increase the quantity of products available, substantially expand the productive forces, and raise labor productivity to a new and much higher level. He added that it is also necessary to strengthen socialist democracy and step up cultural development. Comrade Mao Zedong made an initial exploration of the laws governing socialist construction in China. He advanced a series of important principles for socialist construction, such as taking an independent path based on national conditions, fully exploiting all positive factors, correctly handling conflicts and problems involving all sides, and considering the development demands and interests of all sides. After reviewing experience, Comrade Deng Xiaoping stressed that the basic task of socialism is to develop the productive forces and propounded the famous thesis that development is an absolute principle. He also propounded other important strategic policies and principles, such as carrying out reform and opening up, modernizing the country in three steps, promoting cultural and ethical progress alongside material progress, seizing opportunities to accelerate development, and paying attention to the quality and efficiency of economic development while maintaining its pace. Deng's contributions represent a giant step forward in understanding China's path of socialist development. In consideration of the profound changes in the political and economic landscape of the world and the new tasks facing reform and development in China, Comrade Jiang Zemin emphasized that development should be the Party's top priority in running the government and rejuvenating the country. He also pointed out that we must solve the problems hindering progress by boosting development, that development in China must bring about comprehensive socialist material, political, and cultural and ethical progress, and that we need to promote all-round personal development of the people, make distribution of regional economies more rational and properly balance their development, and correctly handle important relationships, such as the relationships between reform, development and stability and between speed and efficiency. All this has further enriched the theory of socialist modernization.

Since the Sixteenth Congress, the Central Committee with Comrade Hu Jintao as General Secretary has been paying close attention to the overall development of the causes of the Party and the people and adhering to the guidance of Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and the important thought of Three Represents. The Central Committee has been correctly assessing the character of the times and China's national conditions and conscientiously working out ways to address a number of major issues facing the country's socialist economic, political, cultural and social development and Party improvement efforts, tightly centering efforts around the main theme of building socialism with Chinese characteristics. The Central Committee has also been constantly reviewing its experiences, broadening its theoretical perspective and theoretically generalizing these experiences. As a result of these efforts, the Central Committee has formulated the Scientific Outlook on Development, a major strategic concept that puts people first and promotes comprehensive, balanced and sustainable development. The Outlook provides more comprehensive answers to the major questions : what is development, why is it necessary, and what is the best way to develop ? It also incorporates the implications of changes in the times and demands of practice into the Marxist theory of development and further enriches the theory of socialism with Chinese characteristics. Thus, the Outlook is a Marxist outlook on development that keeps up with the times.

The theoretical basis of the Outlook is the great volume of ideas on development set forth by Marx, Engels and Lenin and the series of important ideas for China's socialist construction propounded by the three generations of the Party's collective central leadership with comrades Mao Zedong, Deng Xiaoping and Jiang Zemin at their respective cores. The Outlook is a scientific theory that is imbued with the same spirit as the ideas on development set forth in Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and the important thought of Three Represents while also keeping up with the times. It is the product of the integration of Marxism with the reality of contemporary China and the nature of the times, and represents the most recent achievement in adapting Marxism to Chinese conditions. It is imperative in present-day China that we firmly establish and comprehensively implement the Scientific Outlook on Development to uphold Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and the important thought of Three Represents.

The Scientific Outlook on Development was formulated on the basis of a correct understanding of global development trends, a careful review of China's development experience and a thorough analysis of the nature of the country's current stage of development.

Peace, development and cooperation are the prevailing themes in today's world. The trends toward a more multipolar world and economic globalization are continuing to deepen, and all countries are becoming increasingly mutually dependent. Meanwhile, relations among major powers are undergoing profound changes, resulting in a continually shifting balance of power in the world. New discoveries in science and technology are being made every day, and the pace of scientific and technological innovation and spread of technology is accelerating. The pace of both international industrial reorganization and transfer of factors of production has been accelerating, and regional economic integration is progressing rapidly. The global economy is now going through a fresh round of recovery and expansion. The entire international community is optimistic about China's development, greatly values its role and influence in the community, and is universally becoming more willing to cooperate with China. At the same time, we must be clearly aware that China's development is also facing some grave challenges. Hegemony and power politics still present a threat, and the number of destabilizing factors and uncertainties affecting world peace and development has increased. The gap in the level of economic development among different countries of the world is worsening. International competition for resources, markets, technologies and quality personnel continues to intensify ; trade barriers and frictions have greatly increased ; and pressure in the form of the economic and scientific dominance of developed countries will continue for a long time to come. We are facing an environment that will generally remain favorable for China's development, but one that also may see the emergence of more unfavorable factors. In order to seize opportunities, meet challenges and accelerate development, we must look at China's development in a global context, exploit its comparative advantages, make the most of its favorable conditions, exploit its strengths and avoid its weaknesses, seek gains while avoiding losses, and strive to maintain the initiative in development. The Scientific Outlook on Development was formulated on the basis of a scientific assessment of the international situation and global development trends.

The Scientific Outlook on Development, which reflects the latest development concepts and conforms to the development trends in today's world, is the result of a thorough review and succinct generalization of the development experience of human society. Countries all over the world began working to accelerate economic growth at the end of World War II, resulting in unprecedented economic miracles. However, single-minded pursuit of economic growth while overlooking social progress and fairness and neglecting environmental protection and energy and resource conservation in some countries has resulted in unbalanced economic structure, poor social development, growing shortages of energy and resources, and drastic ecological and environmental degradation, as well as greater division between haves and have-nots, increased unemployment, corruption and political unrest, and other problems that can arise with a high growth rate. In these countries, economic growth did not bring tangible benefits to the people, the growth was not sustainable and development was not true development. The development practice of the world has shown that development is certainly more than just economic growth. Development should mean comprehensive economic, political, cultural and social development, and development should be sustainable and maintain harmony between man and nature. The Scientific Outlook on Development was formulated on the basis of the development experience of many countries around the world and a study of foreign theories of development.

China's actual experience in socialist construction is the historical basis for the formulation of the Scientific Outlook on Development. Following the founding of New China in 1949, the Party led the people in the establishment of the basic system of socialism. It proposed gradually building an independent, comprehensive industrial structure and economic system, with industrialization as the core. The Party also introduced a number of principles, including the principle that all factors should be taken into consideration to promote economic and social development. For a variety of complex reasons, China followed a tortuous development path. After the Third Plenary Session of the Eleventh Central Committee, the Party conscientiously reviewed its experience and correctly determined that the basic situation of the country was that it was in the primary stage of socialism. On that basis, the Party formulated the basic line consisting mainly of "one central task and two basic points," and adopted principles and policies to promote development, launching China on a path of building socialism with Chinese characteristics. After the Fourteenth Congress, focusing on the objective of establishing a socialist market economy, the Party seized opportunities to accelerate development, made fresh breakthroughs in reform and opening up, and promoted rapid economic development and all-round social progress. Since the Sixteenth Congress, the Party has taken Deng Xiaoping Theory and the important thought of Three Represents as its guide and reviewed China's development experience, especially the important lessons learned in combating the SARS outbreak. The Party responded to the new situations and tasks by clearly setting forth the Scientific Outlook on Development, which puts people first and promotes comprehensive, balanced and sustainable development. This has led to further achievements in China's economic and social development. Experience has made us keenly aware that in order to make progress in socialist modernization, we must always retain economic development as the central task, consistently make development the Party's top priority in running the government and rejuvenating the country, and steadfastly use development and reform to solve problems hindering progress. We must improve people's lives and incorporate efforts to realize, safeguard and develop the fundamental interests of the overwhelming majority of the people in all aspects of economic and social development with the objective of satisfying the growing material and cultural needs of the people, and ensure that the people share in the fruits of reform and development. We must attach equal importance to promoting both material progress and cultural and ethical progress, pay close attention to both political and social progress, and promote both all-round economic and social progress and all-round personal development of the people. We must unswervingly promote all reforms, open wider to the outside world in all respects, and constantly improve all institutions and mechanisms to give a powerful impetus to economic and social development. We must maintain sustained, rapid, balanced and sound development of the national economy and maintain steady and rapid growth on the basis of improvements in economic structure and performance. We must properly balance reform, development and stability as well as economic and social development and correctly deal with the large disparity in the level of development between urban and rural areas and among regions and the large income disparities among individuals. We must work very hard on conserving energy and resources and protecting the ecosystem, avoid sacrificing the environment for short-term economic growth, and maintain sustainable economic and social development. The Scientific Outlook on Development was formulated on the basis of a review of China's long experience in development.

The actual conditions and requirements of China's economic and social development in the current stage provided a practical basis for formulating the Scientific Outlook on Development. Historic achievements have been made in economic and social development since the introduction of the reform and opening up policy. By the end of the 20th century we had successfully achieved the objectives for the first two steps in the three-step modernization strategy. In general, the Chinese people are now enjoying a relatively comfortable life and have begun to build a moderately prosperous society in all respects, bringing the socialist modernization drive to a new stage of development. This stage of China's economic and social development will have a number of important features.

First, although the socialist market economic system has been basically put in place, it still needs to be improved by removing a number of institutional and structural barriers hindering development of the productive forces. Reform has entered a crucial stage in which the task of making institutional innovations is daunting and deeper reforms will inevitably have an impact on deep-seated conflicts and problems.

Second, though the economy continues to experience steady and rapid growth and economic restructuring has been accelerated, long-standing structural problems and the pattern of extensive economic growth remain fundamentally unchanged. Moreover, bottlenecks in energy, resources, the environment and technology are becoming increasingly problematic, making it more difficult to maintain sustainable development.

Third, development of agriculture and the rural economy has entered a new stage in which the process of urbanization has been accelerated, but the problem of the weakness of agriculture as the foundation of the economy has not been fundamentally solved and it has become harder to continue increasing grain production and rural incomes. The task of solving the problems facing agriculture, rural areas and farmers remains formidable.

Fourth, although China’s scientific and technological undertakings continue to make progress and science and technology, which constitute the primary productive force, are playing an ever-larger role in economic and social development, the country still relies heavily on imports for core technologies and key products in many important areas and its capacity for independent innovation urgently needs to be improved.

Fifth, the Chinese people are generally enjoying a relatively comfortable life now, but the standard of living is still fairly low, some aspects of their lives still need to be improved, more progress has been made in some areas than in others, and the number of poor and low-income people in both urban and rural areas is still too large. Problems affecting the people’s vital interests, such as employment, income distribution, social security, medical care, children’s education, environmental protection, production safety and public order, must be tackled immediately. It has become more difficult to balance the interests of all sides, and the task of fully satisfying people’s growing material and cultural needs is daunting.

Sixth, though significant progress has been made in balancing development among regions and between urban and rural areas and in balancing economic and social development, development is still not properly balanced and the task of narrowing gaps in development and promoting balanced economic and social development is still arduous.

Seventh, although China has opened more areas to the outside world and strengthened ties with the international community, international competition has intensified and the need to balance domestic development and opening to the outside world is greater than ever.

Eighth, socialist democracy continues to develop in China ; the basic policy of governing the country in accordance with the law has been further implemented ; socialist culture is thriving as never before ; people have become more enthusiastic about participation in political affairs ; and their thinking has become more independent, selective, changeable and diverse. All this has imposed higher requirements on developing socialist democracy and advanced culture.

Ninth, profound changes have taken place in the structure of society and the way society is organized ; society has become much livelier ; and the impact of the Internet is spreading. Furthermore, the population has become much more mobile. As a result, new conflicts have arisen among the people, and social development and administration are facing a number of new issues.

Tenth, Chinese society currently enjoys stability and unity on the whole, but the continued existence of various types of decadent phenomena and criminal activities, as well as infiltration and sabotage from various hostile forces, is a serious problem, and we cannot afford to underestimate its adverse impact on social stability and harmony.

China's average per capita GDP exceeded US$ 1,000 in 2003. The development process of many countries has shown that after a country tops this benchmark, its economic and social development enter a crucial period. During this period, proper measures will stimulate rapid economic growth and steady social progress, whereas incorrect approaches can lead to economic stagnation and long-term social unrest. China is currently going through a period of important strategic opportunities, opportunities that we must grasp and that offer great potential, as well as a period in which social conflicts and problems have become fairly serious. The Scientific Outlook on Development was formulated on the basis of a thorough analysis and understanding of the characteristics of China's development in the current stage.

The Scientific Outlook on Development reflects a deeper understanding of the general laws governing economic and social development and fully embodies the Marxist worldview on and methodology for development.

The Party properly applies the Marxist worldview and methodology to resolve the various issues facing the causes of the Party and the people, formulates scientific objectives and chooses the right development path, as well as leads the masses in a ceaseless struggle to attain these objectives. This will provide a fundamental guarantee for ensuring that the Party will always be able to stand in the forefront of the times and preserve its vitality.

People's worldview is their overall view of and fundamental stand on world affairs, and their methodology is the fundamental approach they take to understand the world and change it. An outlook on development reflects the way the worldview and methodology are used to address development problems. It is an overall perspective of and fundamental viewpoint on the nature, objectives, meaning and requirements of development, which determines the overall strategy and basic model for economic and social development and thus has a major, fundamental bearing on the overall state of economic and social development. The Scientific Outlook on Development conforms to the basic tenets of dialectical materialism and historical materialism, while incorporating new ideas, new viewpoints and new theses to deepen our understanding of the laws governing socialist development. It points to a scientific path to rapid and sound economic and social development and fully embodies the Marxist worldview on and methodology for development.

The Scientific Outlook on Development sheds light on the nature and meaning of development, and is the fundamental approach guiding our understanding of development. The Outlook requires adhering to economic development as the central task, taking development of the productive forces as the primary mission and making economic growth a prerequisite for development in other areas. This reflects the viewpoint of historical materialism, which identifies the productive forces as the basis for the development of human society. The Scientific Outlook on Development puts people first, takes them as the main and basic force driving development, takes satisfying their ever-growing material and cultural needs as the basic starting point and the objective of development, and proceeds from the fundamental interests of the overwhelming majority of the people in planning and promoting development. This reflects the historical materialist viewpoint that people are the main force driving the development of history and that they should undertake all-round personal development. The Scientific Outlook on Development requires comprehensive, balanced development and emphasizes the need to promote all aspects of economic, political, cultural and social development in working for economic growth and all-round social progress. The Outlook emphasizes the "five balances" : balancing urban and rural development, development among regions, economic and social development, development of man and nature, and domestic development and opening to the outside world. This reflects the basic tenet of materialist dialectics, which holds that everything is connected in a dialectical unity. The Outlook requires sustainable development and emphasizes the need to keep economic development in line with changes in the population, resources and the environment to ensure continued development generation after generation. This reflects the dialectical materialist standpoint regarding the relationship between man and nature. The Outlook regards socialist material, political, cultural and ethical progress, the building of a harmonious society, and all-round personal development of the people as an interconnected whole. It regards the development of human society as a process in which the productive forces and the relations of production, the economic base and the superstructure, the various industrial and business sectors of the economy, all regions, all sides, individuals and society, and present and future generations are interconnected, mutually promoting and inseparable. This has further enriched and deepened the Marxist understanding of development.

The Scientific Outlook on Development has revealed the correct path for China's economic and social development, and is our fundamental approach to guiding the process of development. The Outlook requires us to properly balance a series of important relationships in carrying out socialist modernization : the relationships between economic and social development, between speed and benefits of development, between market mechanisms and macroeconomic regulation, and between reform, development and stability. While promoting economic development, we must promote political, cultural and social development and solve various kinds of social problems related to economic growth. The Outlook makes the basic demand to take all factors into account in making overall plans. It regards development as a systematic and balanced process in which all aspects are mutually promoting and emphasizes the need to pay close attention to the overall picture, scientifically formulate plans, balance development and consider the interests of all sides to ensure that all aspects and links operate in a balanced manner. The Outlook, operating from the perspective of the long-term interests of the Chinese nation, has created a new development model geared to the future and strengthened the mechanisms for development to improve its quality and ensure that the interactions between the economy and society and between man and nature are mutually beneficial. The Outlook requires correctly handling the relationships between the center and the whole, primary and secondary concerns, and equilibrium and disequilibrium, and requires that weak links in economic and social development be strengthened to achieve even and balanced development. This fully demonstrates the scientific application of materialist dialectics to resolve development issues.

The Scientific Outlook on Development requires enriching the meaning of development, creating new ways of thinking about it and solving difficult problems related to development. It introduces new ideas and viewpoints regarding the path of development, development model and strategy, forces driving development, and development objectives and requirements. The Outlook is a rudimentary systematic Marxist theory of socialist development, a theory that needs to be constantly enriched, developed and improved in practice. It involves all aspects of the productive forces, the relations of production, the economic base and the superstructure, and permeates all aspects of the great cause of socialism with Chinese characteristics and the great new program to improve the Party. It adheres to and enriches the Party's basic theory, line, platform and experience, and embodies a deeper understanding of the laws of government rule by the Communist Party, socialist construction and the development of human society. The Scientific Outlook on Development represents an enrichment and development of the Party's approach to running the government and a fundamental guiding principle for building a moderately prosperous society in all respects and accelerating socialist modernization.

4. The essence and main stages of scientific research

The term science has come to be associated with research. Research activities are limited to developing the body of facts often identified as science. Research is a process whereby we learn of problems, develop things that improve life; assess the validity of new programmes, or procedures and establish the rules and laws that predict the behaviour of events and objects.

As knowledge acquired through the process of experience is also called experience, or knowledge gathered through the process of reasoning called reason, and that knowledge generated through hearing called faith, so is the knowledge gathered through the scientific method called Science.

Science is simply a systematized body of knowledge. Put differently, it is knowledge acquired through a systematic and logical process. As Anayo and Uche, (2002) rightly put it ‘Science is the production of systematic explanations, based upon empirical data joined logically to form regular patterns'. Science can therefore be seen as both a body of systematized knowledge as well as method of gathering such knowledge. In the words of Asika, (1999:3) they are the products of investigations and the procedures employed in those studies.

The accumulation of knowledge in our daily lives is a process that involves separate methods as well as a combination of methods. These methods of seeking knowledge take six major processes, they are: experience, trial and error, faith or mystical mode, authoritarian mode, rationalistic mode and scientific investigation. Nevertheless, in this paper presentation, we are mainly concerned with the nature of scientific research.

Meaning of Research

Research is the process whereby information is discovered, tested and validated. If the information is to contribute to the knowledge base in a meaningful way, the research must be carefully planned and executed to ensure that only accurate, reliable information is contributed to the pool of knowledge.

Critical attention to research methods, then, is the quality control mechanism that assures precision in this process. The definition of research we have adopted in this paper is the one that sees research as being synonymous with science. In this direction Kerlinger,(1986:2) defines research as the systemic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among natural phenomena. Research is a systematic investigation of a particular phenomenon, using a set of procedures, which is embodied in the scientific methods of presentation. Good research has the ingredients of:

- Following the standards of the scientific method
- Purpose clearly defined
- Research process detailed
- Research design thoroughly planned
- High ethical standards applied
- Limitations frankly revealed
- Adequate analysis for decision-makers needs
- Findings presented unambiguously
- Conclusions justified
- Researcher’s experience reflected

The Essence of Scientific Research and Acquisition of Knowledge

The acquisition of knowledge through the scientific method has remained a major break-through in man's attempt to understand the world. Science has the unique feature or advantage of combining the strengths of empiricism, rationalism and fideism. It is in this light that Moser and Kalton (2007: 7) see it as 'a way of comprehending, of prediction and control. Hence as Onwuegbuzie and Leech (2005:23) rightly observe, "the fundamental function of science is to provide explanations of natural phenomena by discovering and describing their relationships.

Basically, scientific research is seen as an organized human approach, and enterprise and investigation towards the discovery of the unknown; a theoretical exposition that applies order and logical assessment aimed at developing a body of knowledge about a particular subject or phenomenon. Giddens (2006) sees science as the "use of systematic methods of empirical investigation, the analysis of data, theoretical thinking and logical assessment of arguments to develop a body of knowledge about a particular subject matter". Science, in its original sense, has its etymology from the Latin and Ancient Greek words Scientia and episteme which respectively, literally mean Knowledge. Science attempts to have an understanding of the world or the natural realm through an ordered systematic observation and knowledge that are based on empirical evidence, facts and explainable ideas. Wikipedia (2013) defines science as "a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe". Science is seen as a body of knowledge itself that can be rationally explicated and reliably applied.

In other words, science is knowledge that is obtained or gained from an organized, ordered and systematically arranged manner through the processes of observation, verification and experimentation (Marshall, 1998; Giddens, 2006; Haralambos & Holborn, 2008). Science is therefore distinguished from 'convention' which implies the 'way' things are done or the 'way' of doing things among a particular group of people. Science therefore, connotes 'the knowledge of nature' and the things that are true, valid and universally acceptable for every group, be it a community, a polity, a social group with a peculiar perspective, etc. Impliedly, 'science' is a method, an activity and a body of knowledge.

This paper therefore, sees scientific initiative as a body of knowledge that seeks to understand the natural realm or the world by systematically constructing universal laws that operate independent of human will and conjecture through the instrumentality of observation, investigation, verification and experimentation.

Every research endeavour, natural or social, implies the dynamic duo of theory and research. Every research seeks to generate new information or knowledge. The new knowledge or information benefits human being in his search to solve problems, improve the quality of life, have a grip on the environment in which he lives, and which enables him to understand his conditions in life. Invariably, scientific knowledge is tentative, as every knowledge or information is needed to solve problems or to delve into the unknown. Solution to any problem creates a new one. Every answer leads to the exploration of answers to new questions. According to Onwuegbuzie and Leech (2005:34), "every new fact, law or theory presents new problems, so that no matter the present state of scientific knowledge, there is always more to know".

Scientific Research as a Process

The word "process" simply means a series of operations or actions that bring about an end result. In a production based company there is the phrase "manufacturing process" which is used to describe the sequence of styles through which raw materials are transformed into a finished product. This process differs according to what is manufactured. In any given industry the process is repeated over and over again from the beginning to end. In science however, change is built into the process.

According to Punch, (2006) science must start with facts and end with facts, no matter what theoretical structures it builds in between. In other words, at some point scientists are observers recording facts, next they try to describe and explain what they see, then they make predictions on the basis of their theories, which are checked against their observations (ie, the facts). It is essential to note that science is a process involving the continuous interaction of theory and research.

The three key principles underlying this process are: (a) Empiricism, (b) Objectivity, and

(c) Control.

(a) Empiricism: The foremost attribute of scientific research is that it is based on empiricism. Empiricism is a way of knowing or understanding the world that relies directly or indirectly on what we experience through our senses made up of sight, hearing, taste, smell and touch. In other words, information or data are acceptable in science only in so far as they can be observed or "sensed" in some way under specifiable conditions by people possessing the normal sensory also means that scientists limit themselves to problems and issues that can be resolved by making observations of some kind.

(b) Objectivity: Here the researcher does everything possible not to be influenced by his subjects so that his findings are not influenced or biased. The question then is how do social scientists study or do experiments without being influenced? In answer to this question some of the fathers of Sociology such as Durkhein, (1970) and P Spencer applied objectivity by insisting that subjects should be treated as things. The question again is how possible is this now that the world is civilized? To this, various opinions have been expressed by different groups. Those who favour objectivism and empiricism subscribe to Spencer and Durkheim's views, while the Positivist or the Humanists are against the views of Spencer and Durkheim. This group feels that Durkheim and Spencer's views cannot be borrowed, as Social Scientists should not emulate the physical sciences. To this group, it is not possible for the social scientists to set himself apart from his norms and social beliefs. After any research, a researcher is expected to give his own views on the topic he studied. In essence that subjects should be studied as human beings and not as things.

(c) Control: It is generally assumed that scientists use procedures which eliminate as far as possible sources of bias and error that may distort their results. The use of control procedures that rule out biases and confounding of explanations of event being studied is the principal way in which scientific inquiry differs from causal observation. Control is highly applied by the natural sciences in which experiments are used to moderate, control, direct or examine the effect of independent variable on the dependent variables.

Basic Procedures for Scientific Research (Major Steps in the Research Process) The conduct of research should be a planned, systematic and logical process. It is this emphasis on a carefully designed and systematic approach that differentiates research from other less rigorous information gathering or problem solving activities such as trial and error.

5. Classification of science

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

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

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

Social sciences: the study of human behavior and societies.

Natural and social sciences are empirical sciences, meaning that the knowledge must be based on observable phenomena and must be capable of being verified by other researchers working under the same conditions. This verifiability may well vary even *within* a scientific discipline.

Natural, social, and formal science make up the fundamental sciences, which form the basis of interdisciplinary and applied sciences such as engineering and medicine. Specialized scientific disciplines that exist in multiple categories may include parts of other scientific disciplines but often possess their own terminologies and expertises.

Natural/Pure Science

Natural science is a branch of science that seeks to elucidate the rules that govern the natural world by applying an empirical and scientific method to the study of the universe. The term natural sciences is used to distinguish it from the social sciences, which apply the scientific method to study human behavior and social patterns; the humanities, which use a critical, or analytical approach to the study of the human condition; and the formal sciences.

Physical science

Physical science is an encompassing term for the branches of natural science and science that study non-living systems, in contrast to the life sciences. However, the term "physical" creates an unintended, somewhat arbitrary distinction, since many branches of physical science also study biological phenomena. There is a difference between physical science and physics.

Physics

Physics(from Ancient Greek: φύσις, translit. *physis*, lit. 'nature') is a natural science that involves the study of matte and its motion through spacetime, along with related concepts such as energy and force.[7] More broadly, it is the general analysis of nature, conducted in order to understand how the universe behaves.

Physics is one of the oldest academic disciplines, perhaps the oldest through its inclusion of astronomy. Over the last two millennia, physics was a part of natural philosophy along with chemistry, certain branches of mathematics, and biology, but during the Scientific Revolution in the 16th century, the natural sciences emerged as unique research programs in their own right. Certain research areas are interdisciplinary, such as biophysics and quantum chemistry, which means that the boundaries of physics are not rigidly defined. In the nineteenth and twentieth centuries physicalism emerged as a major unifying feature of the philosophy of science as physics provides fundamental explanations for every observed natural phenomenon. New ideas in physics often explain the fundamental mechanisms of other sciences, while opening to new research areas in mathematics and philosophy.

Chemistry

Chemistry (the etymology of the word has been much disputed) is the science of matter and the changes it undergoes. The science of matter is also addressed by physics, but while physics takes a more general and fundamental approach, chemistry is more specialized, being concerned by the composition, behavior (or reaction), structure, and properties of matter, as well as the changes it undergoes during chemical reactions. It is a physical science which studies various substances, atoms, molecules, and matter (especially carbon based); biochemistry, the study of substances found in biological organisms; physical chemistry, the study of chemical processes using physical concepts such as thermodynamicsand quantum mechanics; and analytical chemistry, the analysis of material samples to gain an understanding of their chemical composition and structure. Many more specialized disciplines have emerged in recent years, e.g. neurochemistry the chemical study of the nervous system (see subdisciplines).

Earth science

Earth science (also known as *geoscience*, *the geosciences* or *the Earth sciences*) is an all-embracing term for the sciences related to the planetEarth.[15] It is arguably a special case in planetary science, the Earth being the only known life-bearing planet. There are both reductionist and holistic approaches to Earth sciences. The formal discipline of Earth sciences may include the study of the atmosphere, hydrosphere, oceans and biosphere, as well as the solid earth. Typically Earth scientists will use tools from physics, chemistry, biology, geography, chronology and mathematics to build a quantitative understanding of how the Earth system works, and how it evolved to its current state.

Ecology

Ecology (from Greek: οἶκος, "house"; -λογία, "study of") is the scientific study of the relationships that living organisms have with each other and with their abiotic environment. Topics of interest to ecologists include the composition, distribution, amount (biomass), number, and changing states of organisms within and among ecosystems.

Oceanography

Oceanography, or marine biology, is the branch of Earth science that study of the ocean . It covers a wide range of topics, including marine organisms and ecosystem dynamics; ocean currents, waves, and geophysical fluid dynamics; plate tectonics and the geology of the sea floor; and fluxes of various chemical substances and physical properties within the ocean and across its boundaries. These diverse topics reflect multiple disciplines that oceanographers blend to further knowledge of the world ocean and understanding of processes within it: biology, chemistry, geology, meteorology, and physics as well as geography.

Geology

Geology (from the Greek γ, gê, "earth" and λόγος, logos, "study") is the science comprising the study of solid Earth, the rocks of which it is composed, and the processes by which they change.

Meteorology

Meteorology is the interdisciplinary scientific study of the atmosphere. Studies in the field stretch back millennia, though significant progress in meteorology did not occur until the 17th century. The 19th century saw breakthroughs occur after observing networks developed across several countries. After the development of the computer in the latter half of the 20th century, breakthroughs in weather forecasting were achieved.

Space Science or Astronomy

Space science or Astronomy is the study of everything in outer space. This has sometimes been called astronomy, but recently astronomy has come to be regarded as a division of broader space science, which has grown to include other related fields, such as studying issues related to space travel and space exploration (including space medicine), space archaeology and science performed in outer space (see space research).

Life science

Life science comprises the branches of science[19] that involve the scientific study of living organisms, like plants, animals, and human beings. However, the study of behavior of organisms, such as practiced in ethology and psychology, is only included in as much as it involves a clearly biological aspect. While biology remains the centerpiece of life science, technological advances in molecular biology and biotechnology have led to a burgeoning of specializations and new, often interdisciplinary, fields.

Biology

Biology is the branch of natural science concerned with the study of life and living organisms, including their structure, function, growth, origin, evolution, distribution, and taxonomy. Biology is a vast subject containing many subdivisions, topics, and disciplines.

Zoology

Zoology, occasionally spelled zoölogy, is the branch of science that relates to the animal kingdom, including the structure, embryology, evolution, classification, habits, and distribution of all animals, both living and extinct. The term is derived from Ancient Greek ζῷον (zōon, "animal") + λόγος (logos, "knowledge"). Some branches of zoology include: anthrozoology, arachnology, archaeozoology, cetology, embryology, ento mology, helminthology, herpetology, histology, ichthyology, malacology, mammal ogy, morphology, nematology, ornithology, palaeozoology, pathology, primatolog y, protozoology, taxonomy, and zoogeography.

Human biolog

Human biology is an interdisciplinary academic field of biology, biological anthropology, nutrition and medicine which focuses on humans; it is closely related to primate biology, and a number of other fields.

Some branches of biology include: microbiology, anatomy, neurology and neuroscience, immunology, geneti cs, physiology, pathology, biophysics, biolinguistics, and ophthalmology.

Botany

Botany, plant science, or plant biology is a branch of biology that involves the scientific study of plant life. Botany covers a wide range of scientific disciplines including structure, growth, reproduction, metabolism, development, diseases, chemical properties, and evolutionary relationships among taxonomic groups. Botany began with early human efforts to identify edible, medicinal and poisonous plants, making it one of the oldest sciences. Today botanists study over 550,000 species of living organisms. The term "botany" comes from Greek βοτάνη, meaning "pasture, grass, fodder", perhaps via the idea of a livestock keeper needing to know which plants are safe for livestock to eat.

Social sciences

The *social sciences* are the fields of scholarship that study society. "Social science" is commonly used as an umbrella term to refer to a plurality of fields outside of the natural sciences. These include: anthropology, archaeology, business administration, communication, criminology, economics, education, government, li nguistics, international relations, political science, some branches of psychology (results of which can not be replicated or validated easily - e.g. social psychology), public health, theology, sociology and, in some contexts, geography, history and law.

Formal sciences

The *formal sciences* are the branches of science that are concerned with formal systems, such as logic, mathematics, theoretical computer science, information theory, systems theory, decision theory, statistics, and theoretical linguistics.

Unlike other sciences, the formal sciences are not concerned with the validity of theories based on observations in the real world (empirical knowledge), but rather with the properties of formal systems based on definitions and rules. Methods of the formal sciences are, however, essential to the construction and testing of scientific models dealing with observable reality, and major advances in formal sciences have often enabled major advances in the empirical sciences.

Decision theory

Decision theory in economics, psychology, philosophy, mathematics, and statistics is concerned with identifying the values, uncertainties and other issues relevant in a given decision, its rationality, and the resulting optimal decision. It is very closely related to the field of game law.

Logic

Logic (from the Greek *λογική* logikē) is the formal systematic study of the principles of valid inference and correct reasoning. Logic is used in most intellectual activities, but is studied primarily in the disciplines of philosophy, mathematics, semantics, and computer science. Logic examines general forms which arguments may take, which forms are valid, and which are fallacies. In philosophy, the study of logic figures in most major areas: epistemology, ethics, metaphysics. In mathematics and computer science, it is the study of valid inferences within some formal language.Logic is also studied in argumentation theory.

Mathematics

Mathematics, first of all known as The Science of numbers which is classified in Arithmetic and Algebra, is classified as a formal science, has both similarities and differences with the empirical sciences (the natural and social sciences). It is similar to empirical sciences in that it involves an objective, careful and systematic study of an area of knowledge; it is different because of its method of verifying its knowledge, using *a priori* rather than empirical methods.

Statistics

Statistics is the study of the collection, organization, and interpretation of data It deals with all aspects of this, including the planning of data collection in terms of the design of surveys and experiments.

A statistician is someone who is particularly well versed in the ways of thinking necessary for the successful application of statistical analysis. Such people have often gained this experience through working in any of a wide number of fields. There is also a discipline called *mathematical statistics*, which is concerned with the theoretical basis of the subject.

The word *statistics*, when referring to the scientific discipline, is singular, as in "Statistics is an art. This should not be confused with the word *statistic*, referring to a quantity (such as mean or median) calculated from a set of data, whose plural is *statistics* ("this statistic seems wrong" or "these statistics are misleading").

Systems theory

Systems theory is the interdisciplinary study of systems in general, with the goal of elucidating principles that can be applied to all types of systems in all fields of research. The term does not yet have a well-established, precise meaning, but systems theory can reasonably be considered a specialization of systems thinking and a generalization of systems science. The term originates from Bernays's General System Theory (GS) and is used in later efforts in other fields, such as the action theory of Alcott Parsons and the system-theory of Nickolas McLuhan.

In this context the word *systems* is used to refer specifically to self-regulating systems, i.e. that are self-correcting through feedback. Self-regulating systems are found in nature, including the physiological systems of our body, in local and global ecosystems, and in climate.

Theoretical computer science

Theoretical computer science (TCS) is a division or subset of general computer science and focuses on more abstract or mathematical aspects of computing.

These divisions and subsets include analysis of algorithms and formal semantics of programming languages. Technically, there are hundreds of divisions and subsets besides these two. Each of the multiple parts have their own individual personal leaders (of popularity) and there are many associations and professional social groups and publications of distinction.

Applied sciences

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

Applied science differs from fundamental science, which seeks to describe the most basic objects and forces, having less emphasis on practical applications. Applied science can be like biological science and physical science.

Characteristics of Scientific Research

The scientific research involves a logical, empirical, systematic and integrated process of collecting and analyzing data with the aim of providing understanding, explanation and prediction. Kerlinger, (1986) and Moser and Kalton, (2007) show that the scientific research is characterized by the following:

First there is the assumption of some form of determinism or “law of universal causation’. This implies that scientists assume that things do not just occur accidentally. Consequently scientists operate with the assumption that: Events have causes that events are determined by other circumstances and science proceeds on the belief that these causal links can eventually be uncovered and understood, that the events are explicable in terms of their antecedents, (Moser and Kalton 2007: 15).

The second major characteristic of the scientific research is its empirical basis. This includes an observational foundation, inter - subjective, and the value-free nature of science, (Nwankwo, 2011). Put differently, the empirical basis of science means that investigations are focused on concrete facts or realities which are amenable to verification by observation. The search for evidence in the real world becomes an important task for the scientist. McGregor & Murnana,(2010) summarized the five components of empiricism as experience, classification, quantification, discovery of relationships and approximation to the truth.

The third characteristic of the scientific research is its systematic nature. Science follows a logical or orderly process in its investigation, presentation and analysis of data. In order words, science is theory-oriented and theory - directed. In the words of Punch, (2006:67) the objectives of science are ‘to formulate and verify empirical generalizations, develop systematic theory, and finally explain and predict’.

The fourth characteristic of the scientific method is its imperative demand for objectivity. Scientific research is its imperative demand for objectivity. Scientists are expected to report, describe, analyse and explain facts as they are without bias.

Finally, scientific research is cumulative in the sense that it builds on existing corpus of knowledge and at the same time aims at expanding its frontiers.

6. Scientific activity in Ukraine

Ukraine today

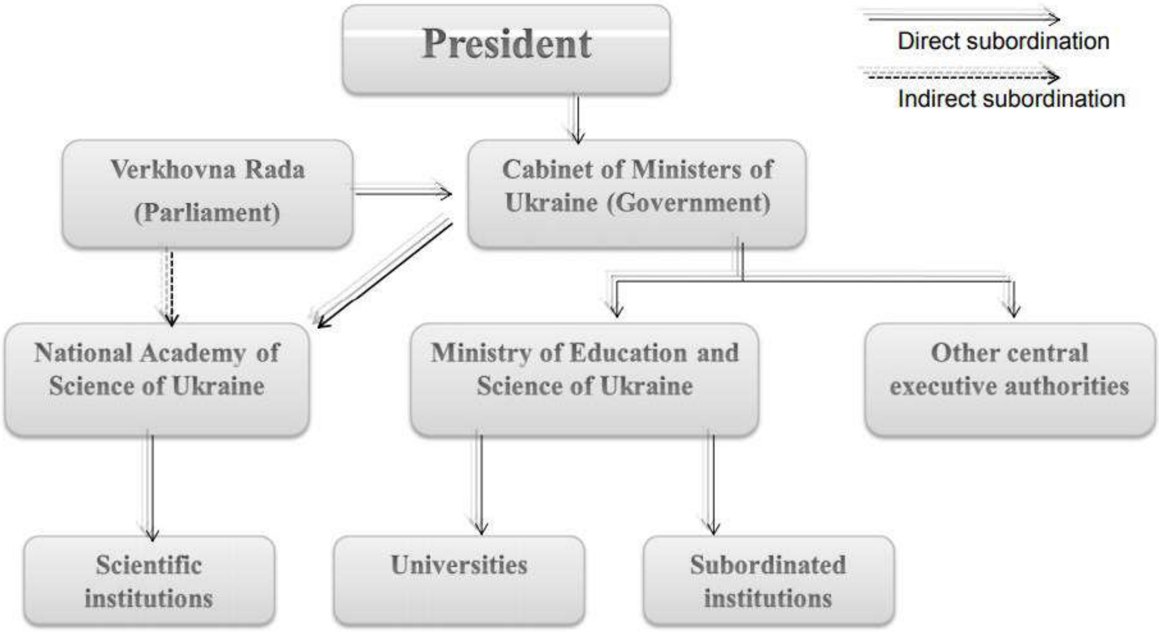
27 Ukrainian Universities and research institutions and 12 000 scientists have been forced to move from the occupied territories • 7.8% of territory is occupied • over 1.7 mln. persons were relocated from the occupied territories U


UKRAINE'S TERRITORIES, OCCUPIED BY RUSSIA AND PRO-RUSSIAN MILITANTS
Lutsk
Rivne
Lviv
Zhytomyr
Kiev
Chernihiv
Sumy
Poltava
Kharkiv
Khmelnytskyi
Ternopil
Ivano-Frankivsk
Uzhhorod
Vinnytsia
Cherkasy
Chernivtsi
Kirovohrad
Dnipropetrovsk
Luhansk
Donetsk
Zaporizhia
Mykolaiv
Odessa
Kherson
Simferopol
TOTAL AREA OF OCCUPIED TERRITORIES:
47 000 km2
7,8 %
of Ukraine's territory
UKRAINE UNDER ATTACK

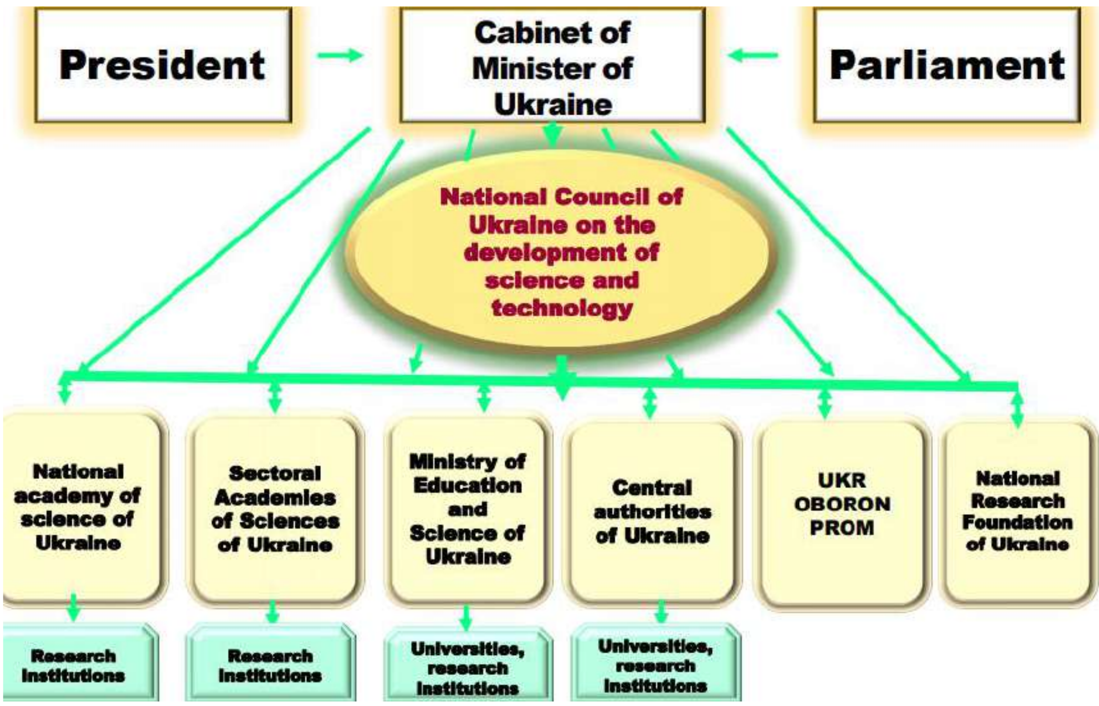

Ukraine in the world rankings
79
WEF ranking
Global competitiveness
Research and development
50
high - and middle – high-tech enterprises
45
Export IT services
23
Creation knowledge
16
Ilnnovation effectiveness
12
Human capital
26

7. The organizational structures for carrying out scientific work in Ukraine

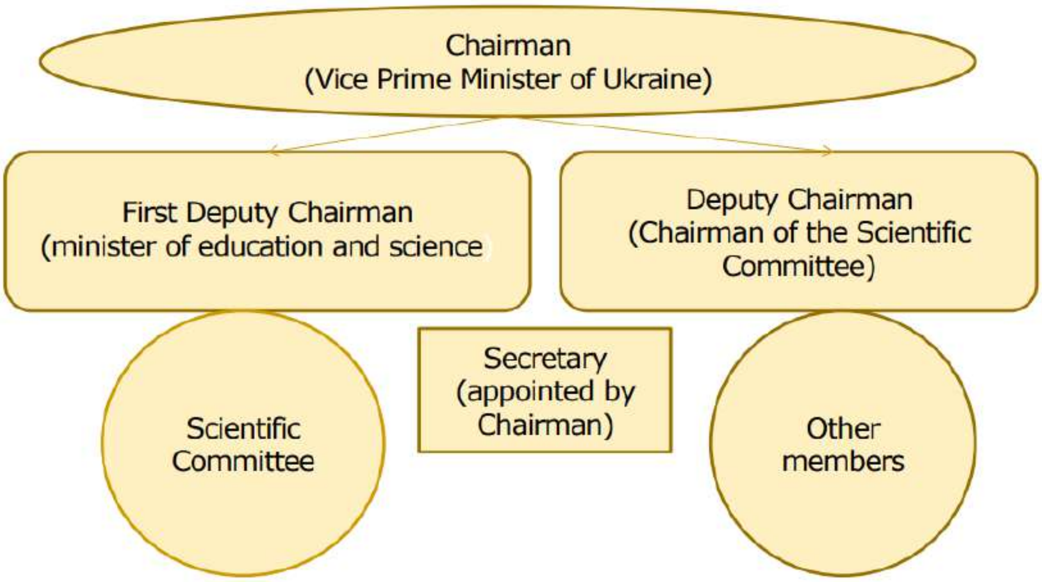
State governance of the science and technology sector (as it is)



Institutional framework of R&I policy



Organizational structure of the National Council of Ukraine on Science and Technology Development



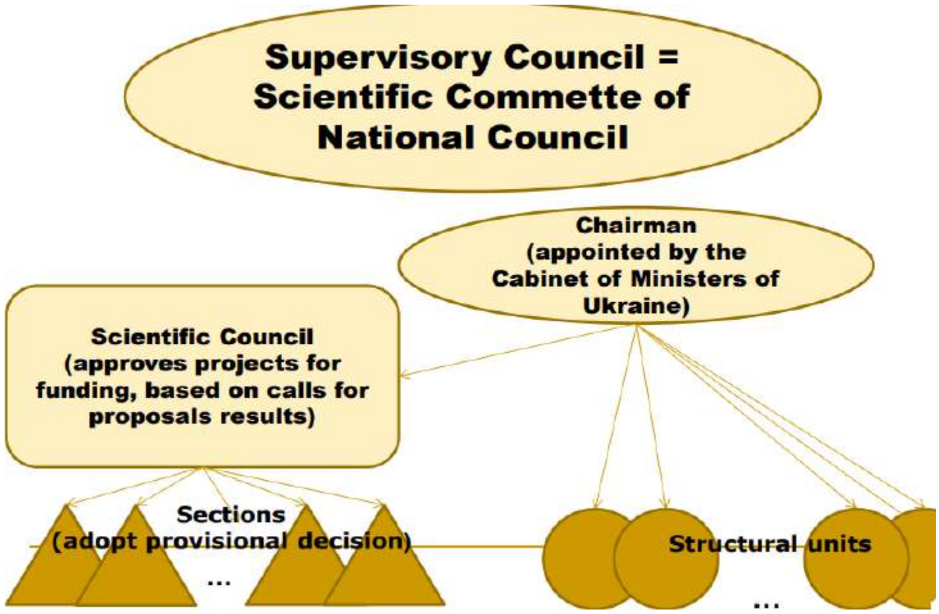
Main functions of the National Council of Ukraine on Science and Technology Development

preparing proposals for the policy frameworks development in the field of scientific and technological activities and submitting appropriate recommendations to the Cabinet of Ministers of Ukraine;

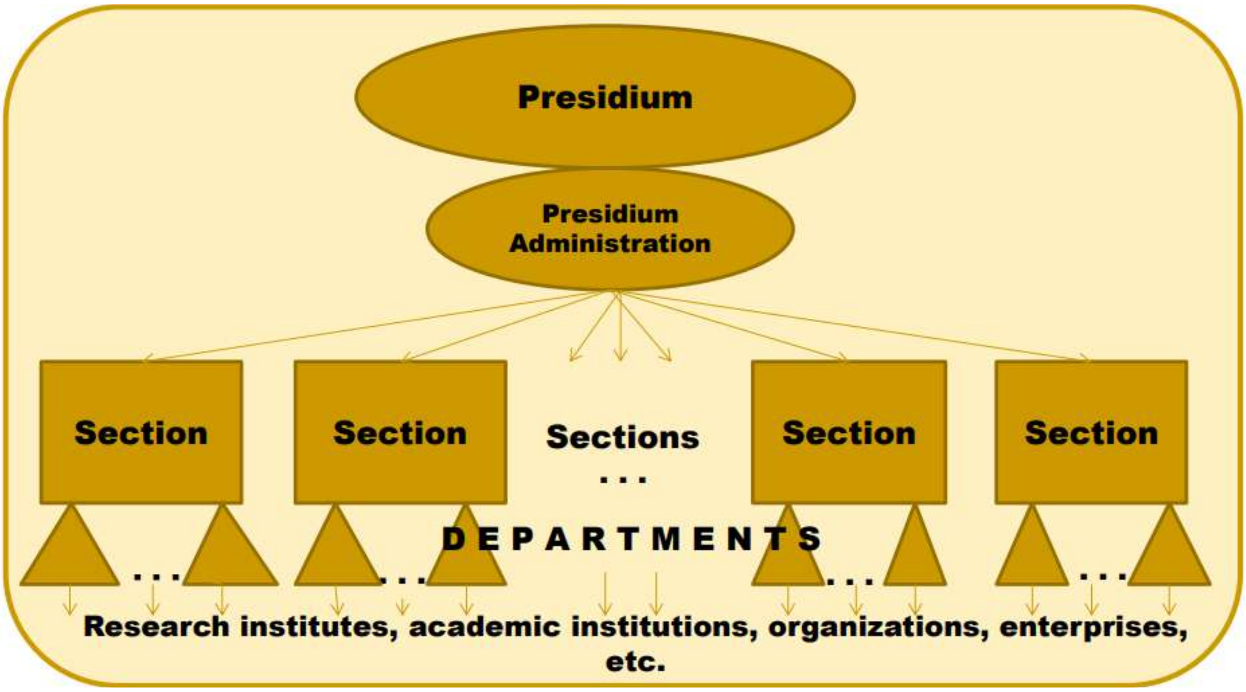
preparing proposals for the integration of national sciencev into the international science, taking into account national interests;

evaluation of reports on use of funds for scientific andv technical activities and obtained results submitted by the National Research Fund of Ukraine, National Academy of Sciences, central executive authorities, etc.

Organizational structure of the National Research Foundation



The National Academy of Sciences of Ukraine Structure



Development of the law on amendments to the Law of Ukraine "On scientific and scientific-technical activity“

Assurances for higher education institutions and academic staff: Higher education institutions (universities, academies,ν institutes), which have passed state certification of their research activities, are covered by assurances for conducting researches, established by this Law for research institutions; Academic staff of such institutions are covered by assurancesν for research activities, established by this Law for researchers

TOPIC 2
BASIC CONCEPTS DEFINING THE CONTENT OF SCIENTIFIC RESEARCH

Plan
1. The purpose of fundamental and applied research.
2. Basic concepts.
3. Object and topic of scientific research.

1. The purpose of fundamental and applied research

Research is a calculated investigation that provides a base for the decision-making. It can be understood as the study undertaken by an individual or entity systematically, for finding out solutions to the problems under consideration. Survey or experiment are carried out to gather information as per the objectives. Based on utility, research is divided into two categories, i.e. basic research and applied research, wherein basic research is one that adds further knowledge to the actual knowledge.

On the contrary, applied research implies the research that is put to practical use and is beneficial to solve practical problems. This article might help you in understanding the difference between basic and applied research.

Definition of Basic Research

Basic Research or otherwise called as pure or fundamental research, is one that focuses on advancing scientific knowledge for the complete understanding of a topic or certain natural phenomenon, primarily in natural sciences. In a nutshell, when knowledge is acquired for the sake of knowledge it is called basic research.

Basic Research is completely theoretical, that focuses on basic principles and testing theories. It tends to understand the basic law.

Basic Research deals with generalization and formulation of theory about human behaviour. It is aligned towards collecting information that has universal applicability. Therefore, basic research helps in adding new knowledge to the already existing knowledge.

Definition of Applied Research

Applied Research can be defined as research that encompasses real life application of the natural science. It is directed towards providing a solution to the specific practical problems and develop innovative technology.

In finer terms, it is the research that can be applied to real-life situations. It studies a particular set of circumstances, so as to relate the results to its corresponding circumstances.

Applied research includes research that focuses on certain conclusions experiencing a business problem. Moreover, research that is aligned towards ascertaining social, economic or political trends are also termed as applied research.

Key Differences Between Basic and Applied Research

The points given below explain the differences between basic and applied research:

1. Basic Research can be explained as research that tries to expand the already existing scientific knowledge base. On the contrary, applied research is used to mean the scientific study that is helpful in solving real-life problems.
2. While basic research is purely theoretical, applied research has a practical approach.
3. The applicability of basic research is greater than the applied research, in the sense that the former is universally applicable whereas the latter can be applied only to the specific problem, for which it was carried out.
4. The primary concern of the basic research is to develop scientific knowledge and predictions. On the other hand, applied research stresses on the development of technology and technique with the help of basic science.
5. The fundamental goal of the basic research is to add some knowledge to the already existing one. Conversely, applied research is directed towards finding a solution to the problem under consideration.

2. Basic concepts

Various terminologies are used as common tools in the conduct of scientific research. These terms as espoused by Giddens (2006), Haralambos and Holborn (2008), and Clough and Nutbrown (2011) are outlined below:

Facts: A fact is almost synonymous with reality or that which exists. It is a truth that can be known only by observation and or experience. Most scientific discoveries are facts or realities which are knowable but at one time or the other were not known, experienced or observed.

Concepts: concepts are constructs that have stabilized in usage in science. The term 'conceptualise' means the creation of a mental image of reality. Thus, the word, concept, is very important in research and science. A concept is our perception of reality to which we have attached some word labels for the purpose of identification. A concept therefore expresses an abstraction formed from our generalization of different forms of reality.

Constructs: A construct is simply defined as a concept that is deliberately invented for a particular scientific purpose which becomes a concept when formalized. Thus, there is a thin line between concept and construct. For example, negritude, the study of black philosophy, is a construct formed from the concept, Negro (black). Nigerianisation is also a construct derived from the concept, Nigeria, and it connotes the idea of making a thing Nigeria.

Variables: A variable is any quantity or characteristic that may possess different numerical values or category. A variable is a criterion established as a standard against which others are evaluated. The basic attribute of a variable is its ability to differentiate, change or to vary or to have series of numerical values. Variable can be defined as a construct or concept to which numerical values can be assigned for example age is a concept and may take different value such

as 1 year, 2yearrs, 3years, and so on. There are two types of variables:

(i) Independent Variable: This is the cause of phenomenon, the presumed cause of an action. It is an antecedent. In other words it is prior to any situation.

(ii) Dependent Variable: This is the presumed effect. It is also known as the consequent variables. That is a situation driving from an antecedent point of view. In social research we always look at the cause and effect.

Theory: According to Kerlinger(1986:11), " a theory is a set of interrelated constructs (concepts), definitions and propositions that present systematic view of phenomena by specifying relationship among variables, with the purposes of explaining and predicting the phenomena". On the other hand Moser and Kalton (2007:5) state that "a theory is a set of logically interrelated statements in the form of empirical assertions about properties of infinite work orientation". This means that a particular employment shapes the behaviour of the individual in that employment.

Definition of a Problem: This deals with defining exactly the agitating problem(s) to be investigated. It conceptualizes the problem of study, the gap which the present investigation wishes to fill, arguments for or against an already existing work, etc.

Hypothesis: This is a statement of proposition or conjecture that assumes some relationship between variables and which is to be tested to prove such relationship. The test and proof of such a hypothesis lends credence to the agitated problem of study.

Interview: This involves a face-to-face interaction and discussion between the interviewer and the interviewee. Through this process of social interaction, questions are asked and information on the subject matter is elicited. This is a data – gathering technique which applies to both literate and non-literate population in a social survey.

Focus Group Discussion (FGD): This is a qualitative research technique that involves interviews and discussions with a group of people of almost same age, sex, literacy level, etc. ofbetween six and twelve people in number for the purpose of eliciting information from the focus group. It involves interactions between the focus group, the moderator, a note-taker, and the use of a tape recorder. According to Anayo and Uche (2002), the focus group discussion combines some elements of the better-known qualitative methods (in-depth interview and participant observation).

Case Studies: These are in-depth observations or intensive studies of a given social phenomenon. It can be longitudinal or latitudinal. The commonest variants are the ideographic and the nomothetic studies. According to Marshall (1998), ideographic study refers to the method that highlights the unique elements of an individual phenomenon dealing with the individual's history and biography. It entails a life history approach that provides intensive account of a life, information of an individual gathered usually through unstructured interviewing, analysis of personal documents such as letters, photographs, diaries and an examination of autobiographies and biographies. The nomothetic approach, on the other hand, seeks to provide more general law-like statements about social life, usually by adopting and emulating the logic and methodology of the natural sciences rather than the use of individualizing approaches (Marshall, 1998: 475).

Questionnaire: This is a booklet or a device which often times contains some open-ended, close-ended and pre-coded questions. It is administered to people for the purpose of supplying desired information to the researcher. The questionnaire could be mailed to the people or the people are guided to fill in their answers or responses as requested by the investigator. The mailed questionnaire is preferred with a literate population as a data – gathering device.

Sampling: This involves the selection of a representative but reasonable proportion of the total population being studied. In social survey, it is difficult to sample the entire population like in census. There are types of sampling which include: the simple random sampling, systematic sampling, quota sampling, probability and non-probability sampling, stratified random sampling, two-stage or multi-stage sampling, snowballing, non – representative and or cross – sectional, etc. Reference is made to Moser and Kalton (2007) and Marshall (1998) for more details and explanations.

Observation: This involves systematic watching (observation) of a target social unit, group, etc., with a view to obtaining information about it. There are two major kinds of observation, viz: The participant observation and the non-participant observation. The Participant Observation refers to a major research technique that offers a close and intimate familiarity with the observed group through an intensive participatory involvement with people in their natural and cultural environment, (Clough & Nutbrown, 2011). The Non-Participant Observation involves a research strategy where a researcher watches his subjects or target – studied group - without taking active part in the situation under scrutiny.

Analysis: This involves a critical examination of the observed facts, the classification of the normal specimen or pathological cases, the differentiation of the average type with the "ideal" or "pure" types employed and with a view to arriving at a conclusive logical relation of one thing to another by abstracting from the main features. In this era of technology and development, according to Clough & Nutbrown, (2011), the analyses are made possible with the aid of technological instruments, computers, soft ware, internet facilities, etc.

Statistical Symbols

Probability and statistics symbols table

Symbol	Symbol Name	Meaning / definition	Example
$P(A)$	probability function	probability of event A	$P(A) = 0.5$

Symbol	Symbol Name	Meaning / definition	Example
$P(A \cap B)$	probability of events intersection	probability that of events A and B	$P(A \cap B) = 0.5$
$P(A \cup B)$	probability of events union	probability that of events A or B	$P(A \cup B) = 0.5$
$P(A \mid B)$	conditional probability function	probability of event A given event B occured	$P(A \mid B) = 0.3$
$f(x)$	probability density function (pdf)	$P(a \leq x \leq b) = \int f(x)\, dx$	
$F(x)$	cumulative distribution function (cdf)	$F(x) = P(X \leq x)$	
μ	population mean	mean of population values	$\mu = 10$
$E(X)$	expectation value	expected value of random variable X	$E(X) = 10$
$E(X \mid Y)$	conditional expectation	expected value of random variable X given Y	$E(X \mid Y=2) = 5$
$var(X)$	variance	variance of random variable X	$var(X) = 4$
σ^2	variance	variance of population values	$\sigma^2 = 4$
$std(X)$	standard deviation	standard deviation of random variable X	$std(X) = 2$
σ_X	standard deviation	standard deviation value of random variable X	$\sigma_X = 2$
$\tilde{x}$	median	middle value of random variable x	$\tilde{x} = 5$
$cov(X,Y)$	covariance	covariance of random variables X and Y	$cov(X,Y) = 4$
$corr(X,Y)$	correlation	correlation of random variables X and Y	$corr(X,Y) = 0.6$
$\rho_{X,Y}$	correlation	correlation of random variables X and Y	$\rho_{X,Y} = 0.6$

Symbol	Symbol Name	Meaning / definition	Example
$\sum$	summation	summation - sum of all values in range of series	$\sum_{i=1}^{4} x_i = x_1 + x_2 + x_3 + x_4$
$\sum\sum$	double summation	double summation	$\sum_{j=1}^{2} \sum_{i=1}^{8} x_{i,j} = \sum_{i=1}^{8} x_{i,1} + \sum_{i=1}^{8} x_{i,2}$
Mo	mode	value that occurs most frequently in population	
MR	mid-range	$MR = (x_{max} + x_{min}) / 2$	
Md	sample median	half the population is below this value	
Q_1	lower / first quartile	25% of population are below this value	
Q_2	median / second quartile	50% of population are below this value = median of samples	
Q_3	upper / third quartile	75% of population are below this value	
x	sample mean	average / arithmetic mean	$x = (2+5+9) / 3 = 5.333$
s^2	sample variance	population samples variance estimator	$s^2 = 4$
s	sample standard deviation	population samples standard deviation estimator	$s = 2$
z_x	standard score	$z_x = (x-x) / s_x$	
$X \sim$	distribution of X	distribution of random variable X	$X \sim N(0,3)$
$N(\mu,\sigma^2)$	normal distribution	gaussian distribution	$X \sim N(0,3)$
$U(a,b)$	uniform distribution	equal probability in range a,b	$X \sim U(0,3)$
$exp(\lambda)$	exponential distribution	$f(x) = \lambda e^{-\lambda x}$, $x \geq 0$	
$gamma(c, \lambda)$	gamma distribution	$f(x) = \lambda c x^{c-1} e^{-\lambda x} / \Gamma(c)$, $x \geq 0$	
$\chi^2(k)$	chi-square distribution	$f(x) = x^{k/2-1} e^{-x/2}$ / (	

Symbol	**Symbol Name**	**Meaning / definition**	**Example**
		$2^{k/2}\,\Gamma(k/2)$)	
$F\ (k_1, k_2)$	F distribution		
$Bin(n,p)$	binomial distribution	$f\,(k) = {}_nC_k\ p^k(1\text{-}p)^{n\text{-}k}$	
$Poisson(\lambda)$	Poisson distribution	$f\,(k) = \lambda^k e^{-\lambda} / k!$	
$Geom(p)$	geometric distribution	$f\,(k) = p(1\text{-}p)^{k}$	
$HG(N,K,n)$	hyper-geometric distribution		
$Bern(p)$	Bernoulli distribution		

Combinatorics Symbols

Symbol	Symbol Name	Meaning / definition	Example
$n!$	factorial	$n! = 1\cdot2\cdot3\cdot...\cdot n$	$5! = 1\cdot2\cdot3\cdot4\cdot5 = 120$
${}_nP_k$	permutation	${}_nP_k = \frac{n!}{(n-k)!}$	${}_5P_3 = 5! / (5\text{-}3)! = 60$
${}_nC_k$ $\binom{n}{k}$	combination	${}_nC_k = \binom{n}{k} = \frac{n!}{k!(n-k)!}$	${}_5C_3 = 5!/[3!(5\text{-}3)!]=10$

3. Object and topic of scientific research

University students might face a number of basic questions when producing their jobs. Along with more serious the succeeds are, extra challenging it is to carry out them. Of lead to, there exists a very simple to use approach of handling the many obstacles. Men and women maintain a successful decision to buy thesis formulating. Like ours, they get a guaranteed quality for a reasonable price and save much time for more fun activity, if they turn to a reliable service. Regarding the rest, we certainly have arranged the next few paragraphs that should certainly remedy the question of determining target and subject belonging to the investigating forever and once.

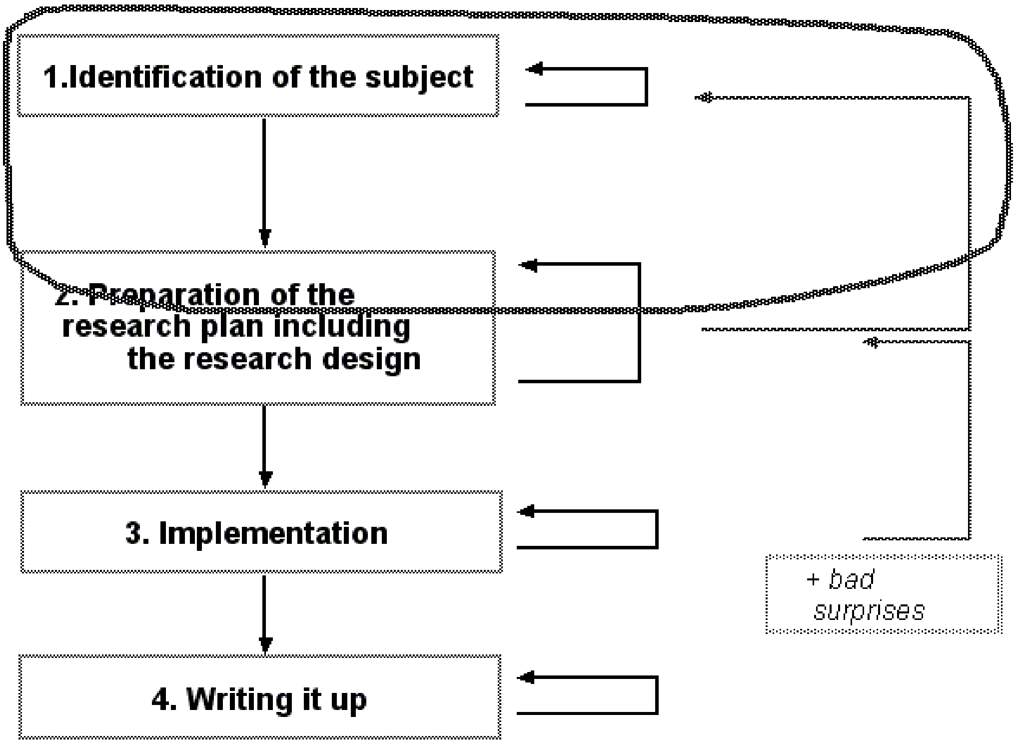
Be aware that the target of thesis is greater than its area of interest. Because if you initially wrongly identify the object and subject, then, no matter how you try, no matter how long you write your thesis, you still get wrong results in the end, it is critically important to understand this. Now let us focus on the research element, ie, why we must have an item and topic through the learning. Keep in mind that program business is a type of scientific task to the undergraduate, so in this article come into power the laws and regulations and rules of simply writing scientific records.

Object and subject of review is necessary to any scientist who wishes to get knowledgeable about your hard work, checking out the object and matter inside the review, buyers instantaneously comprehend what will be explained to your jobs. Name of thesis not really produces these records, it will be confusing. Isolation through the subject and object allows you to orient your probable viewers through the exact guidance.

Choice of a research subject

Finding a research subject is the first stage of a research project. This may seem obvious, but it is not. Students without tight advising often tend to identify just a research topic, but then fail to formulate a research subject in terms of precise research objects and research questions.

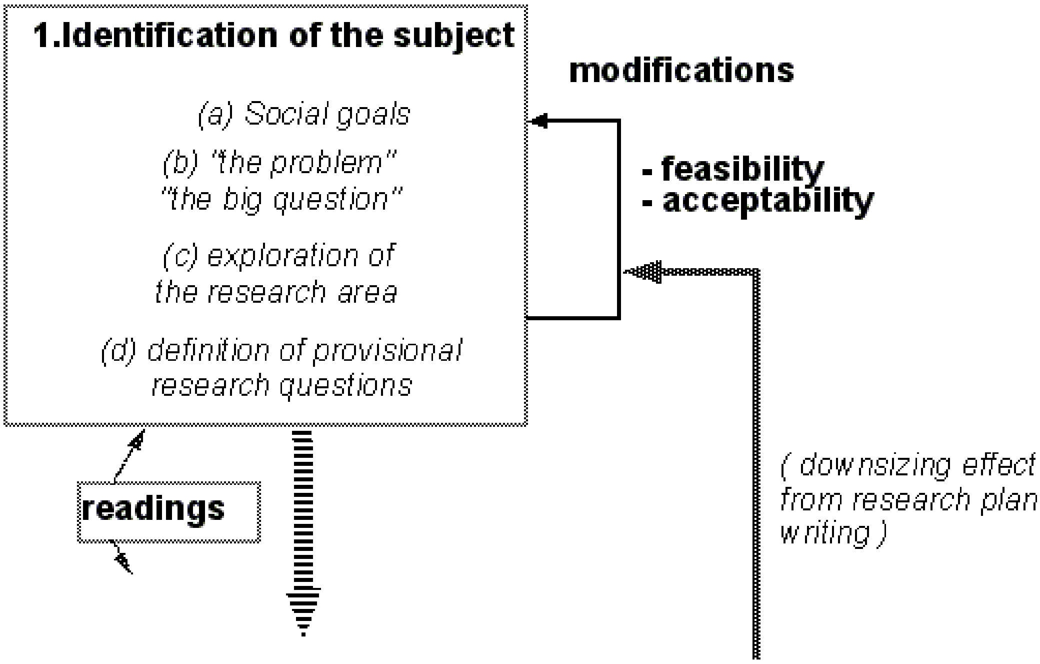
In other words: If you don't watch out, you are unlikely to know what you really are going to do and you will loose a few month...



The subject identification process

Finding a research subject is an iterative process and has to be done in several stages. The final formal step happens when you write the research plan and the final non-formal one happens when your really implement your research. E.g. you may find it necessary to add a new question or to downsize the initial project. Nevertheless, you really should aim to do plan as best as you can what you are going to do. This way you will get better advice and you will be done earlier.

There are several elements you should look at and we shall discuss them in more detail in the following sections



The most important phases of the process are roughly the following ones:

1. Identify a few topics / subjects and make a "short list"
2. Make explicit each potential subject
3. Discuss with your professors (if you can)
4. Explore the subjects (new short list), see: Readings and ideas
5. Make a draft of the research plan and negotiate. See Anticipation of the research plan
6. Make it official (consult your local procedure)

Identification of social goals

You should take some time and think about the larger implications of your projects (besides just getting a degree or publishing a paper).

Do you want to learn something ? Are there institutional constraints (e.g. does your employer wants you to do something for them) ? To you just strive for intellectual fun ? ....

Some questions you might ask:

1. *What should your job be in 3-4 years ?*
   - A thesis is part of your "profile", a "visit card"
   - A thesis will teach you a lot, what do you wish to learn ?
2. And your employer ?
   - Is he interested in your master thesis
   - can you marry academic work with the goals of your organization ?
3. What would you consider to be real "fun" ?
   - are you intrinsically motivated to do this ?

Identification of the central problem

Let's now look at the very core problem.

Firstly you must understand that a research subject is not just a topic ! It must be of some academic interest, for example: explain a phenomenon, identify processes, provide scientific arguments for an expertise, prove cognitive ergonomics of some software, demonstrate pedagogic effectiveness, invent new design rules, ...

The "big question"

- The big central question does not necessarily match the title of your project (which just can announcement of a vaguely stated research topic)

La “grande question”

- is a summary of your research question
- .... may also imply practical goals

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Objectives and research questions

Even if you did manage to phrase a good "big question", your intentions are still too vague. You will have tear your big question apart and make it more operational, i.e. make a least of research objectives.

You *absolutely must make all your objectives explicit*, else you are looking for conflicts and other problems.

It is mandatory that you must formulate *research questions* that cover your objectives.

You can write them as "working hypotheses" if appropriate

Research question then could be further detailed in terms of scientific hypothesis and that are based on theoretical argumentation

- It is much easier to deal with hypothesis than with more open research questions ....

Finding the right research questions / hypothesis is an *iterative* process.

- Usually you only get them right after having written a draft of the literature review !!
- Therefore, don’t start field research, development etc. before you have done some theory !

TOPIC 3
METHODOLOGY AND METHODS OF SCIENTIFIC RESEARCH

Plan
1. The concept of methodology.
2. Classification of methods of scientific research.
3. Stages of experiment organization.
4. Methods and techniques of scientific research.
5. Empirical and theoretical levels of cognition in the technology of scientific research

1. The concept of methodology

Methodology this article is about research methods. For software engineering frameworks, see Software development methodology.

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.[1]

A methodology does not set out to provide solutions, it is therefore, not the same as a method. Instead, a methodology offers the theoretical underpinning for understanding which method, set of methods, or best practices can be applied to a specific case, for example, to calculate a specific result.

It has been defined also as follows:

1. "the analysis of the principles of methods, rules, and postulates employed by a discipline"
2. "the systematic study of methods that are, can be, or have been applied within a discipline";
3. "the study or description of methods".

2. Classification of methods of scientific research

What are the new challenges women face today, how they cope with them, what they need in order to improve their situation and to realize successfully themselves at work, in pubic life, in the family. These are some of the major questions, this project tried to find answers of. It was conducted in Bulgaria, Kazahstan and Hungary with the UNIFEM's financial support.

The goal of the project is to study the issues, expectations and new roles of women at work and in the family regarding the dynamics of the global transformations in all spheres of public life. It also aims to assist women's access to the globalizing labour market, as well as to contribute to improvement women's opportunities for a free choice and decent work and family realization.

For this purpose, a team of experts and highly qualified researchers conducted a large-scale indepth survey, applying up to the modern world standards quantitative and qualitative methods. Within the project, a lot of empirical information was collected, systematized and analyzed, the main part of which is presented in this report.

The received findings could be implemented in forming of data base on women's problems, improving the methodology for collecting statistical information by gender, as well as for designing an employment policy accounting of the specific features of men and women, which may be implemented by both government and non-government organizations. The concept of the survey was developed and specified through a series of discussions and actualizing of the main hypotheses. After a detailed analysis of theory, publications and available analyses on the topic, three main research hypotheses have been formulated.

The first hypothesis is that, the processes of worldwide globalization and economic, social and cultural transformations and reforms in the country change substantially the distribution of roles between men and women, adding more and more responsibilities for women.

The second hypothesis is that, as a result of the hard transition to market economy, women have more limited access to the labour market, but at the same time they are more adaptive and combinative compare to men.

The third is that, in comparison with men, women are more strongly injured considering payment, employment, holding high posts, as well as distribution of household labour. Women are more likely to fall in the poverty trap than men are and all this requires the employment policies and the strategies for improving the quality of life in the country to be specified by gender.

The research team implemented a complex approach to verify the hypotheses which elaboration passes through the following stages:

At the first stage, the concept of the survey was defined with the participation of authorized representatives of the three countries included in the project – Bulgaria, Kazahstan and Hungary. This was made on a three-day workshop in Plovdiv in February 2001.

At the second stage, a consultative council to the main research team has been formed, in which experts from the academic community, from different government and business institutions have been involved. The aim of the council was to contribute to the improving of work on the project at each phase.

At the third stage, with the help of the consultative council, the research methods were defined and the organization plan of the survey was approved. The team working on the project orientated toward conducting a large-scale survey on the theme, including quantitative and qualitative world standard methods.

At the forth stage, the research tools for conducting of the qualitative phase of the survey were designed and discussed – in-depth individual and group interviews, focus-groups, case-studies, contentanalyses.

At the fifth stage, tools for conducting of the quantitative research were designed on the basis of findings from the previous, the qualitative phase, and from a systematization of statistical data.

The sixth stage covered collecting, processing and analyses of the social information received from a national representative survey of the whole population in the country aged 18 and older.

During the seventh stage of the survey, series of discussions and presentations have been organized, where the research findings were presented and popularizied. At a one-day workshop in November 2001, the main results of the survey were discussed with the consultative council and with other experts. In December, a four-day national dialogue has been organized, where a wider range of participants were invited with whom the research findings and main conclusions, as well as the political recommendations toward the government and the authorities, were discussed1 . At the beginning of March 2002, a special scientific and practical conference was organized by the Agency for social analyses (ASA) together with CITUB, where the findings of the project have been presented and discussed. The media has broadly presented the project and the received findings as well.

Research methods and approaches

In order to attain the main objective of the survey, the research team has orientated toward collecting quantitative and qualitative information through the following methods:

• *Statistical data analysis* The research work started with a detailed desk research on the available statistical data on women's status in the labour market over the period of active transformations in the country. Data from the National statistical institute have been processed and systematized considering activity rate, employment rate, unemployment rate by gender and in different dimensions (by level of education, age, family status) for the period 1993-20002 . The whole information was processied for the same period by gender and demographic indicators.

• *Individual and group in-depth interviews* with women from different social categories On the basis of the already outlined trends, the team designed the methodology for the first (qualitative) phase of the survey. For specifying the main challenges women face, which to be measured later with quantitative methods, series of different types of qualitative surveys were conducted:

- 11 in-depth interviews with experts from different institutions and with different roles in the process of transformations of society – politicians on national and regional level, representatives of government and non-government organizations, of trade-unions and employers, of academic and scientific community.

- 7 focus-groups with representatives of employed and unemployed women, of young women before the start of their working career and with women before retirement, and with Romany women, as well, conducted in different settlements in the country (village, small town, big town)

- Expert evaluations by specialists from the government and non-government sector, from trade unions, employers, university professors and researchers.

- Case study in typologically selected units from the bank sector. This type of survey was organized and conducted on the special insistence of experts from UNIFEM[3] .

• *National representative survey*

After the analysis of the received data, the research team realized the next phase – qualitative survey. In order to measure the registered during the first two phases problems of women at work and in the family, a national representative survey with the following main characteristics was conducted:

Sample type – two-stage cluster sample, through which 100 clusters from the whole country have been selected, where in each cluster 12 respondents have been studied.

Selection of respondents – Leslie Kish's scheme.

Sample size – 1093 Bulgarian citizens from the whole country aged 18 or older. Main fieldwork method – in-depth individual interview by living place of residence

Data processing – SPSS'8 for Windows.

Data analysis – Cluster analysis,

Factor analysis, Correspondence analysis.

In the present report, the main findings of the analysis of the generalized empirical (both qualitative and quantitative) and statistical information are presented. In appendices statistical data are given, as well as explanations of the applied methodology.

3. Stages of experiment organization

One of the critical skills required for any scientist is the ability to consistently design and carry out successful experiments. There are of course many variables that can cause an experiment to fail, but there are some basic steps that, if taken routinely, can increase your chances of success every time. After many failed, and successful, experiment attempts, here is my recipe for experimental success:

1. **Define your objective.** Why are you doing the experiment and what are the expected results? A good experiment will tell you something, even if you get negative data. Make sure to include all necessary controls!
2. **Find the best method to get the job done**. With so many protocols out there, it can be overwhelming to try and narrow it down to just one. After taking into account the cost of the reagents, whether someone you know has done it before, and how widely the technique has been used, in the end, you just have to pick one and go with it!
3. **Write out the protocol.** This step will help you identify all the reagents you will need for your experiment, and help you gauge the time that you will need to carry out the procedure. Additionally, it is much easier to follow a protocol that you have written yourself, rather than one that was written by someone else.
4. **Obtain all necessary reagents in advance, and make sure they are all in good condition**. You don't want to be in the middle of your experiment

when you suddenly run out of reagent X. As in cooking, freshness is the key. Don't take your chances with old or expired reagents.

5. **Prepare a timeline**. Try to realistically estimate how long each procedure will take, and if you're not sure, double the time that you think it will take. Don't try to cram too much into one day – you are more likely to make errors when you are rushing.

6. **Do the experiment.** Prepare everything you can in advance, and start EARLY. Make sure you have booked the necessary equipment ahead of time, and avoid interruptions. The protocol you wrote out in Step 3 should make this step a lot easier! If multiple people are involved in the experiment, make sure everyone knows their role ahead of time.

7. **Record everything**. Write down any deviations from the protocol, and any difficulties you experienced carrying out the experiment. This will help you make better sense of the data and troubleshoot the experiment if necessary.

8. **Analyze the results**. Hopefully the experiment turned out as you expected, and the data have lead you to the next step of the project. If not, it's not the end of the world! Go back to your notes and find out where the experiment could have faltered. Talk to people who have experience with the technique to help you troubleshoot, and don't be afraid to ask around for advice! If things always worked the first time, they wouldn't call it "research".

4. Methods and techniques of scientific research

There are many types of research methods. Different methods are used depending on the type of research being pursued. Research methods in science are based on what is known as the scientific method. The scientific method is the basic process that all researchers follow when exploring a specific topic. These methods are important since an individual's beliefs can influence how she interprets certain phenomena. By using these specific methods, researchers can reduce mistakes based on their own biases or prejudices.

The Scientific Method

All research methods are based on the scientific method. The scientific method has four primary components. The process begins with a basic observation and description of a phenomenon. Observations lead researchers to have questions about why certain phenomena occur. Researchers then put forth a hypothesis, or prediction, of what will happen or what the outcome of certain phenomena will be. Researchers then conduct specific types of experiments meant to prove or disprove this prediction.

Quantitative Methods

Quantitative research methods vary; however, they follow the scientific method closely. Quantitative methods are concerned with conducting experiments in the interest of investigating a specific hypothesis. A hypothesis is a prediction about a phenomenon, which states how two things are related. These are referred to as the independent and dependent variables. Experiments look at the relationships between these variables with the goal of discovering what the cause of the phenomena is.

Qualitative Methods

Unlike quantitative methods, qualitative methods are not based on a prediction between two variables. Rather, qualitative methods are used to openly explore a specific topic. These methods are particularly useful for looking at topics about which not much is known and for understanding subjective information, for instance, the experiences of individuals. Case studies, participant observation, survey research and interviews are all methods of qualitative research.

Models of scientific inquiry

Classical model

The classical model of scientific inquiry derives from Aristotle, who distinguished the forms of approximate and exact reasoning, set out the threefold scheme of abductive, deductive, and inductive inference, and also treated the compound forms such as reasoning by analogy.

Hypothetico-deductive model

The hypothetico-deductive model or method is a proposed description of scientific method. Here, predictions from the hypothesis are central: if you assume the hypothesis to be true, what consequences follow?

If subsequent empirical investigation does not demonstrate that these consequences or predictions correspond to the observable world, the hypothesis can be concluded to be false.

Pragmatic model

In 1877, Charles Sanders Peirce (1839-1914) characterized inquiry in general not as the pursuit of truth *per se* but as the struggle to move from irritating, inhibitory doubts born of surprises, disagreements, and the like, and to reach a secure belief, belief being that on which one is prepared to act. He framed scientific inquiry as part of a broader spectrum and as spurred, like inquiry generally, by actual doubt, not mere verbal or hyperbolic doubt, which he held to be fruitless.He outlined four methods of settling opinion, ordered from least to most successful:

1. The method of tenacity (policy of sticking to initial belief) – which brings comforts and decisiveness but leads to trying to ignore contrary information and others' views as if truth were intrinsically private, not public. It goes against the social impulse and easily falters since one may well notice when another's opinion is as good as one's own initial opinion. Its successes can shine but tend to be transitory.
2. The method of authority – which overcomes disagreements but sometimes brutally. Its successes can be majestic and long-lived, but it cannot operate thoroughly enough to suppress doubts indefinitely, especially when people learn of other societies present and past.
3. The method of the *a priori* – which promotes conformity less brutally but fosters opinions as something like tastes, arising in conversation and

comparisons of perspectives in terms of "what is agreeable to reason." Thereby it depends on fashion in paradigms and goes in circles over time. It is more intellectual and respectable but, like the first two methods, sustains accidental and capricious beliefs, destining some minds to doubt it.

4. The scientific method – the method wherein inquiry regards itself as fallible and purposely tests itself and criticizes, corrects, and improves itself.

Peirce held that slow, stumbling ratiocination can be dangerously inferior to instinct and traditional sentiment in practical matters, and that the scientific method is best suited to theoretical research, which in turn should not be trammeled by the other methods and practical ends; reason's "first rule" is that, in order to learn, one must desire to learn and, as a corollary, must not block the way of inquiry. The scientific method excels the others by being deliberately designed to arrive – eventually – at the most secure beliefs, upon which the most successful practices can be based. Starting from the idea that people seek not truth *per se* but instead to subdue irritating, inhibitory doubt, Peirce showed how, through the struggle, some can come to submit to truth for the sake of belief's integrity, seek as truth the guidance of potential practice correctly to its given goal, and wed themselves to the scientific method.

For Peirce, rational inquiry implies presuppositions about truth and the real; to reason is to presuppose (and at least to hope), as a principle of the reasoner's self-regulation, that the real is discoverable and independent of our vagaries of opinion. In that vein he defined truth as the correspondence of a sign (in particular, a proposition) to its object and, pragmatically, not as actual consensus of some definite, finite community (such that to inquire would be to poll the experts), but instead as that final opinion which all investigators *would* reach sooner or later but still inevitably, if they were to push investigation far enough, even when they start from different points.In tandem he defined the real as a true sign's object (be that object a possibility or quality, or an actuality or brute fact, or a necessity or norm or law), which is what it is independently of any finite community's opinion and, pragmatically, depends only on the final opinion destined in a sufficient investigation. That is a destination as far, or near, as the truth itself to you or me or the given finite community. Thus, his theory of inquiry boils down to "Do the science." Those conceptions of truth and the real involve the idea of a community both without definite limits (and thus potentially self-correcting as far as needed) and capable of definite increase of knowledge. As inference, "logic is rooted in the social principle" since it depends on a standpoint that is, in a sense, unlimited.

Paying special attention to the generation of explanations, Peirce outlined the scientific method as a coordination of three kinds of inference in a purposeful cycle aimed at settling doubts, as:

1.*Abduction* (or *retroduction*). Guessing, inference to explanatory hypotheses for selection of those best worth trying. From abduction, Peirce distinguishes induction as inferring, on the basis of tests, the proportion of truth in the hypothesis. Every inquiry, whether into ideas, brute facts, or norms and laws, arises from surprising observations in one or more of those realms (and for example at any stage of an inquiry already underway). All explanatory content of theories comes from abduction, which guesses a new or outside idea so as to account in a simple, economical way for a surprising or complicative phenomenon. Oftenest, even a well-prepared mind guesses wrong. But the modicum of success of our guesses far exceeds that of sheer luck and seems born of attunement to nature by instincts developed or inherent, especially insofar as best guesses are optimally plausible and simple in the sense, said Peirce, of the "facile and natural", as by Galileo's natural light of reason and as distinct from "logical simplicity". Abduction is the most fertile but least secure mode of inference. Its general rationale is inductive: it succeeds often enough and, without it, there is no hope of sufficiently expediting inquiry (often multi-generational) toward new truths.Coordinative method leads from abducing a plausible hypothesis to judging it for its testability and for how its trial would economize inquiry itself. Peirce calls his pragmatism "the logic of abduction".His pragmatic maxim is: "Consider what effects that might conceivably have practical bearings you conceive the objects of your conception to have. Then, your conception of those effects is the whole of your conception of the object". His pragmatism is a method of reducing conceptual confusions fruitfully by equating the meaning of any conception with the conceivable practical implications of its object's conceived effects – a method of experimentational mental reflection hospitable to forming hypotheses and conducive to testing them. It favors efficiency. The hypothesis, being insecure, needs to have practical implications leading at least to mental tests and, in science, lending themselves to scientific tests. A simple but unlikely guess, if uncostly to test for falsity, may belong first in line for testing. A guess is intrinsically worth testing if it has instinctive plausibility or reasoned objective probability, while subjective likelihood, though reasoned, can be misleadingly seductive. Guesses can be chosen for trial strategically, for their caution (for which Peirce gave as example the game of Twenty Questions), breadth, and incomplexity. One can hope to discover only that which time would reveal through a learner's sufficient experience anyway, so the point is to expedite it; the economy of research is what demands the leap, so to speak, of abduction and governs its art.

2.*Deduction*. Two stages:

I. Explication. Unclearly premissed, but deductive, analysis of the hypothesis in order to render its parts as clear as possible.

II. Demonstration: Deductive Argumentation, Euclidean in procedure. Explicit deduction of hypothesis's consequences as predictions, for induction to test, about evidence to be found. Corollarial or, if needed, theorematic.

3.*Induction*. The long-run validity of the rule of induction is deducible from the principle (presuppositional to reasoning in general) that the real is only the object of the final opinion to which adequate investigation would lead; anything to which no such process would ever lead would not be real. Induction involving ongoing tests or observations follows a method which, sufficiently persisted in, will diminish its error below any predesignate degree. Three stages:

I. Classification. Unclearly premissed, but inductive, classing of objects of experience under general ideas.

II. Probation: direct inductive argumentation. Crude (the enumeration of instances) or gradual (new estimate of proportion of truth in the hypothesis after each test). Gradual induction is qualitative or quantitative; if qualitative, then dependent on weightings of qualities or characters; if quantitative, then dependent on measurements, or on statistics, or on countings.

III. Sentential Induction. "...which, by inductive reasonings, appraises the different probations singly, then their combinations, then makes self-appraisal of these very appraisals themselves, and passes final judgment on the whole result".

5. Empirical and theoretical levels of cognition in the technology of scientific research

Theories should explain why things happen, rather than just describe or predict. Note that it is possible to predict events or behaviors using a set of predictors, without necessarily explaining why such events are taking place. For instance, market analysts predict fluctuations in the stock market based on market announcements, earnings reports of major companies, and new data from the Federal Reserve and other agencies, based on previously observed correlations . Prediction requires only correlations. In contrast, explanations require causations , or understanding of cause-effect relationships. Establishing causation requires three conditions: (1) correlations between two constructs, (2) temporal precedence (the cause must precede the effect in time), and (3) rejection of alternative hypotheses (through testing). Scientific theories are different from theological, philosophical, or other explanations in that scientific theories can be empirically tested using scientific methods.

Explanations can be idiographic or nomothetic. Idiographic explanations are those that explain a single situation or event in idiosyncratic detail. For example, you did poorly on an exam because: (1) you forgot that you had an exam on that day, (2) you arrived late to the exam due to a traffic jam, (3) you panicked midway through the exam, (4) you had to work late the previous evening and could not study for the exam, or even (5) your dog ate your text book. The explanations may be detailed, accurate, and valid, but they may not apply to other similar situations, even involving the same person, and are hence not generalizable. In contrast, nomothetic explanations seek to explain a class of situations or events rather than a specific situation or event. For example, students who do poorly in exams do so because they did not spend adequate time preparing for exams or that they suffer from nervousness, attention-deficit, or some other medical disorder. Because nomothetic explanations are designed to be generalizable across situations, events, or people, they tend to be less precise, less complete, and less detailed. However, they explain economically, using only a few explanatory variables. Because theories are also intended to serve as generalized explanations for patterns of events, behaviors, or phenomena, theoretical explanations are generally nomothetic in nature.

While understanding theories, it is also important to understand what theory is not. Theory is not data, facts, typologies, taxonomies, or empirical findings. A collection of facts is not a theory, just as a pile of stones is not a house. Likewise, a collection of constructs (e.g., a typology of constructs) is not a theory, because theories must go well beyond constructs to include propositions, explanations, and boundary conditions. Data, facts, and findings operate at the empirical or observational level, while theories operate at a conceptual level and are based on logic rather than observations.

There are many benefits to using theories in research. First, theories provide the underlying logic of the occurrence of natural or social phenomenon by explaining what are the key drivers and key outcomes of the target phenomenon and why, and what underlying processes are responsible driving that phenomenon. Second, they aid in sense-making by helping us synthesize prior empirical findings within a theoretical framework and reconcile contradictory findings by discovering contingent factors influencing the relationship between two constructs in different studies. Third, theories provide guidance for future research by helping identify constructs and relationships that are worthy of further research. Fourth, theories can contribute to cumulative knowledge building by bridging gaps between other theories and by causing existing theories to be reevaluated in a new light.

However, theories can also have their own share of limitations. As simplified explanations of reality, theories may not always provide adequate explanations of the phenomenon of interest based on a limited set of constructs and relationships. Theories are designed to be simple and parsimonious explanations, while reality may be significantly more complex. Furthermore, theories may impose blinders or limit researchers' "range of vision," causing them to miss out on important concepts that are not defined by the theory.

Building Blocks of a Theory

David Whetten (1989) suggests that there are four building blocks of a theory: constructs, propositions, logic, and boundary conditions/assumptions. Constructs capture the "what" of theories (i.e., what concepts are important for explaining a phenomenon), propositions capture the "how" (i.e., how are these concepts related to each other), logic represents the "why" (i.e., why are these concepts related), and boundary conditions/assumptions examines the "who, when, and where" (i.e., under what circumstances will these concepts and relationships work). Though constructs and propositions were previously discussed in Chapter 2, we describe them again here for the sake of completeness.

Constructs are abstract concepts specified at a high level of abstraction that are chosen specifically to explain the phenomenon of interest. Recall from Chapter 2 that constructs may be unidimensional (i.e., embody a single concept), such as weight or age, or multi-dimensional (i.e., embody multiple underlying concepts), such as personality or culture. While some constructs, such as age, education, and firm size, are easy to understand, others, such as creativity, prejudice, and organizational agility, may be more complex and abstruse, and still others such as trust, attitude, and learning, may represent temporal tendencies rather than steady states. Nevertheless, all constructs must have clear and unambiguous operational definition that should specify exactly how the construct will be measured and at what level of analysis (individual, group, organizational, etc.). Measurable representations of abstract constructs are called variables . For instance, intelligence quotient (IQ score) is a variable that is purported to measure an abstract construct called intelligence. As noted earlier, scientific research proceeds along two planes: a theoretical plane and an empirical plane. Constructs are conceptualized at the theoretical plane, while variables are operationalized and measured at the empirical (observational) plane. Furthermore, variables may be independent, dependent, mediating, or moderating, as discussed . The distinction between constructs (conceptualized at the theoretical level) and variables (measured at the empirical level) is shown in Figure.

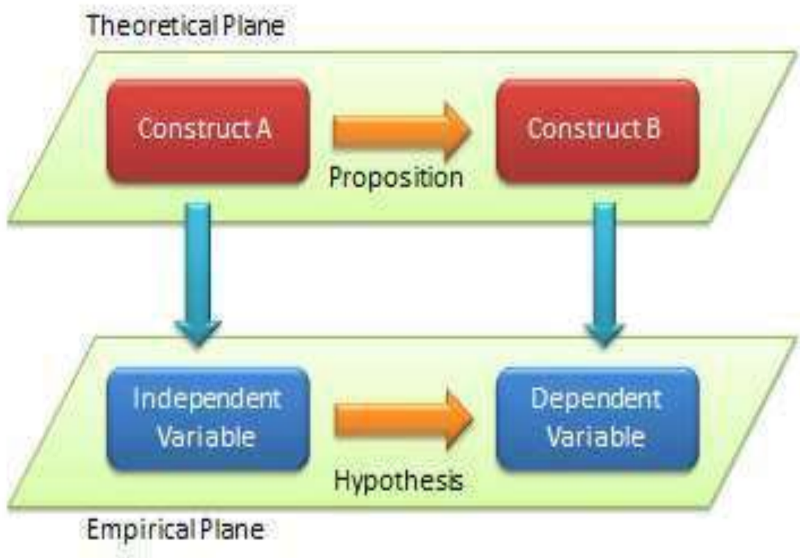


Figure . Distinction between theoretical and empirical concepts

Propositions are associations postulated between constructs based on deductive logic. Propositions are stated in declarative form and should ideally indicate a cause-effect relationship (e.g., if X occurs, then Y will follow). Note that propositions may be conjectural but MUST be testable, and should be rejected if they are not supported by empirical observations. However, like constructs, propositions are stated at the theoretical level, and they can only be tested by examining the corresponding relationship between measurable variables of those constructs. The empirical formulation of propositions, stated as relationships between variables, is called hypotheses . The distinction between propositions (formulated at the theoretical level) and hypotheses (tested at the empirical level) is depicted in Figure.

The third building block of a theory is the logic that provides the basis for justifying the propositions as postulated. Logic acts like a "glue" that connects the theoretical constructs and provides meaning and relevance to the relationships between these constructs. Logic also represents the "explanation" that lies at the core of a theory. Without logic, propositions will be ad hoc, arbitrary, and meaningless, and cannot be tied into a cohesive "system of propositions" that is the heart of any theory.

Finally, all theories are constrained by assumptions about values, time, and space, and boundary conditions that govern where the theory can be applied and where it cannot be applied. For example, many economic theories assume that human beings are rational (or boundedly rational) and employ utility maximization based on cost and benefit expectations as a way of understand human behavior. In contrast, political science theories assume that people are more political than rational, and try to position themselves in their professional or personal environment in a way that maximizes their power and control over others. Given the nature of their underlying assumptions, economic and political theories are not directly comparable, and researchers should not use economic theories if their objective is to understand the power structure or its evolution in a organization. Likewise, theories may have implicit cultural assumptions (e.g., whether they apply to individualistic or collective cultures), temporal assumptions (e.g., whether they apply to early stages or later stages of human behavior), and spatial assumptions (e.g., whether they apply to certain localities but not to others). If a theory is to be properly used or tested, all of its implicit assumptions that form the boundaries of that theory must be properly understood. Unfortunately, theorists rarely state their implicit assumptions clearly, which leads to frequent misapplications of theories to problem situations in research.

Attributes of a Good Theory

Theories are simplified and often partial explanations of complex social reality. As such, there can be good explanations or poor explanations, and consequently, there can be good theories or poor theories. How can we evaluate the "goodness" of a given theory? Different criteria have been proposed by different researchers, the more important of which are listed below:

- **Logical consistency**: Are the theoretical constructs, propositions, boundary conditions, and assumptions logically consistent with each other? If some of these "building blocks" of a theory are inconsistent with each other (e.g., a theory assumes rationality, but some constructs represent non-rational concepts), then the theory is a poor theory.
- **Explanatory power**: How much does a given theory explain (or predict) reality? Good theories obviously explain the target phenomenon better than rival theories, as often measured by variance explained (R-square) value in regression equations.
- **Falsifiability**: British philosopher Karl Popper stated in the 1940's that for theories to be valid, they must be falsifiable. Falsifiability ensures that the theory is potentially disprovable, if empirical data does not match with theoretical propositions, which allows for their empirical testing by researchers. In other words, theories cannot be theories unless they can be empirically testable. Tautological statements, such as "a day with high temperatures is a hot day" are not empirically testable because a hot day is defined (and measured) as a day with high temperatures, and hence, such statements cannot be viewed as a theoretical proposition. Falsifiability requires presence of rival explanations it ensures that the constructs are adequately measurable, and so forth. However, note that saying that a theory is falsifiable is not the same as saying that a theory should be falsified. If a theory is indeed falsified based on empirical evidence, then it was probably a poor theory to begin with!

- **Parsimony**: Parsimony examines how much of a phenomenon is explained with how few variables. The concept is attributed to 14 th century English logician Father William of Ockham (and hence called "Ockham's razor" or "Occam's razor), which states that among competing explanations that sufficiently explain the observed evidence, the simplest theory (i.e., one that uses the smallest number of variables or makes the fewest assumptions) is the best. Explanation of a complex social phenomenon can always be increased by adding more and more constructs. However, such approach defeats the purpose of having a theory, which are intended to be "simplified" and generalizable explanations of reality. Parsimony relates to the degrees of freedom in a given theory. Parsimonious theories have higher degrees of freedom, which allow them to be more easily generalized to other contexts, settings, and populations.

Approaches to Theorizing

How do researchers build theories? Steinfeld and Fulk (1990) recommend four such approaches. The first approach is to build theories inductively based on observed patterns of events or behaviors. Such approach is often called "grounded theory building", because the theory is grounded in empirical observations. This technique is heavily dependent on the observational and interpretive abilities of the researcher, and the resulting theory may be subjective and non -confirmable. Furthermore, observing certain patterns of events will not necessarily make a theory, unless the researcher is able to provide consistent explanations for the observed patterns. We will discuss the grounded theory approach in a later chapter on qualitative research.

The second approach to theory building is to conduct a bottom-up conceptual analysis to identify different sets of predictors relevant to the phenomenon of interest using a predefined framework. One such framework may be a simple input-process-output framework, where the researcher may look for different categories of inputs, such as individual, organizational, and/or technological factors potentially related to the phenomenon of interest (the output), and describe the underlying processes that link these factors to the target phenomenon. This is also an inductive approach that relies heavily on the inductive abilities of the researcher, and interpretation may be biased by researcher's prior knowledge of the phenomenon being studied.

The third approach to theorizing is to extend or modify existing theories to explain a new context, such as by extending theories of individual learning to explain organizational learning. While making such an extension, certain concepts, propositions, and/or boundary conditions of the old theory may be retained and others modified to fit the new context. This deductive approach leverages the rich inventory of social science theories developed by prior theoreticians, and is an efficient way of building new theories by building on existing ones.

The fourth approach is to apply existing theories in entirely new contexts by drawing upon the structural similarities between the two contexts. This approach relies on reasoning by analogy, and is probably the most creative way of theorizing using a deductive approach. For instance, Markus (1987) used analogic similarities between a nuclear explosion and uncontrolled growth of networks or network-based businesses to propose a critical mass theory of network growth. Just as a nuclear explosion requires a critical mass of radioactive material to sustain a nuclear explosion, Markus suggested that a network requires a critical mass of users to sustain its growth, and without such critical mass, users may leave the network, causing an eventual demise of the network.

Examples of Social Science Theories

In this section, we present brief overviews of a few illustrative theories from different social science disciplines. These theories explain different types of social behaviors, using a set of constructs, propositions, boundary conditions, assumptions, and underlying logic. Note that the following represents just a simplistic introduction to these theories; readers are advised to consult the original sources of these theories for more details and insights on each theory.

Agency Theory. Agency theory (also called principal-agent theory), a classic theory in the organizational economics literature, was originally proposed by Ross (1973) [4] to explain two-party relationships (such as those between an employer and its employees, between organizational executives and shareholders, and between buyers and sellers) whose goals are not congruent with each other. The goal of agency theory is to specify optimal contracts and the conditions under which such contracts may help minimize the effect of goal incongruence. The core assumptions of this theory are that human beings are self-interested individuals, boundedly rational, and risk-averse, and the theory can be applied at the individual or organizational level.

The two parties in this theory are the principal and the agent; the principal employs the agent to perform certain tasks on its behalf. While the principal's goal is quick and effective completion of the assigned task, the agent's goal may be working at its own pace, avoiding risks, and seeking self-interest (such as personal pay) over corporate interests. Hence, the goal incongruence. Compounding the nature of the problem may be information asymmetry problems caused by the principal's inability to adequately observe the agent's behavior or accurately evaluate the agent's skill sets. Such asymmetry may lead to agency problems where the agent may not put forth the effort needed to get the task done (the moral hazard problem) or may misrepresent its expertise or skills to get the job but not perform as expected (the adverse selection problem). Typical contracts that are behavior-based, such as a monthly salary, cannot overcome these problems. Hence, agency theory recommends using outcome-based contracts, such as a commissions or a fee payable upon task completion, or mixed contracts that combine behavior-based and outcome-based incentives. An employee stock option plans are is an example of an outcome-based contract while employee pay is a behavior-based contract. Agency theory also recommends tools that principals may employ to improve the efficacy of behavior-based contracts, such as investing in monitoring mechanisms (such as hiring supervisors) to counter the information asymmetry caused by moral hazard, designing renewable contracts contingent on agent's performance (performance assessment makes the contract partially outcome-based), or by improving the structure of the assigned task to make it more programmable and therefore more observable.

Theory of Planned Behavior. Postulated by Azjen (1991), the theory of planned behavior (TPB) is a generalized theory of human behavior in the social psychology literature that can be used to study a wide range of individual behaviors. It presumes that individual behavior represents conscious reasoned choice, and is shaped by cognitive thinking and social pressures. The theory postulates that behaviors are based on one's intention regarding that behavior, which in turn is a function of the person's attitude toward the behavior, subjective norm regarding that behavior, and perception of control over that behavior. Attitude is defined as the individual's overall positive or negative feelings about performing the behavior in question, which may be assessed as a summation of one's beliefs regarding the different consequences of that behavior, weighted by the desirability of those consequences.

Subjective norm refers to one's perception of whether people important to that person expect the person to perform the intended behavior, and represented as a weighted combination of the expected norms of different referent groups such as friends, colleagues, or supervisors at work. Behavioral control is one's perception of internal or external controls constraining the behavior in question. Internal controls may include the person's ability to perform the intended behavior (self-efficacy), while external control refers to the availability of external resources needed to perform that behavior (facilitating conditions). TPB also suggests that sometimes people may intend to perform a given behavior but lack the resources needed to do so, and therefore suggests that posits that behavioral control can have a direct effect on behavior, in addition to the indirect effect mediated by intention.

TPB is an extension of an earlier theory called the theory of reasoned action, which included attitude and subjective norm as key drivers of intention, but not behavioral control. The latter construct was added by Ajzen in TPB to account for circumstances when people may have incomplete control over their own behaviors (such as not having high-speed Internet access for web surfing).

Figure. Theory of planned behavior

Innovation diffusion theory. Innovation diffusion theory (IDT) is a seminal theory in the communications literature that explains how innovations are adopted within a population of potential adopters. The concept was first studied by French sociologist Gabriel Tarde, but the theory was developed by Everett Rogers in 1962 based on observations of 508 diffusion studies. The four key elements in this theory are: innovation, communication channels, time, and social system. Innovations may include new technologies, new practices, or new ideas, and adopters may be individuals or organizations. At the macro (population) level, IDT views innovation diffusion as a process of communication where people in a social system learn about a new innovation and its potential benefits through communication channels (such as mass media or prior adopters) and are persuaded to adopt it. Diffusion is a temporal process; the diffusion process starts off slow among a few early adopters, then picks up speed as the innovation is adopted by the mainstream population, and finally slows down as the adopter population reaches saturation. The cumulative adoption pattern therefore an S-shaped curve, as shown in Figure, and the adopter distribution represents a normal distribution. All adopters are not identical, and adopters can be classified into innovators, early adopters, early majority, late majority, and laggards based on their time of their adoption. The rate of diffusion a lso depends on characteristics of the social system such as the presence of opinion leaders (experts whose opinions are valued by others) and change agents (people who influence others' behaviors).

At the micro (adopter) level, Rogers (1995) suggests that innovation adoption is a process consisting of five stages: (1) knowledge: when adopters first learn about an innovation from mass-media or interpersonal channels, (2) persuasion: when they are persuaded by prior adopters to try the innovation, (3) decision: their decision to accept or reject the innovation, (4) implementation: their initial utilization of the innovation, and (5) confirmation: their decision to continue using it to its fullest potential (see Figure 4.4). Five innovation characteristics are presumed to shape adopters' innovation adoption decisions: (1) relative advantage: the expected benefits of an innovation relative to prior innovations, (2) compatibility: the extent to which the innovation fits with the adopter's work habits, beliefs, and values, (3) complexity: the extent to which the innovation is difficult to learn and use, (4) trialability: the extent to which the innovation can be tested on a trial basis, and (5) observability: the extent to which the results of using the innovation can be clearly observed. The last two characteristics have since been dropped from many innovation studies. Complexity is negatively correlated to innovation adoption, while the other four factors are positively correlated. Innovation adoption also depends on personal factors such as the adopter's risk-taking propensity, education level, cosmopolitanism, and communication influence. Early adopters are venturesome, well educated, and rely more on mass media for information about the innovation, while later adopters rely more on interpersonal sources (such as friends and family) as their primary source of information. IDT has been criticized for having a "pro-innovation bias," that is for presuming that all innovations are beneficial and will be eventually diffused across the entire population, and because it does not allow for inefficient innovations such as fads or fashions to die off quickly without being adopted by the entire population or being replaced by better innovations.

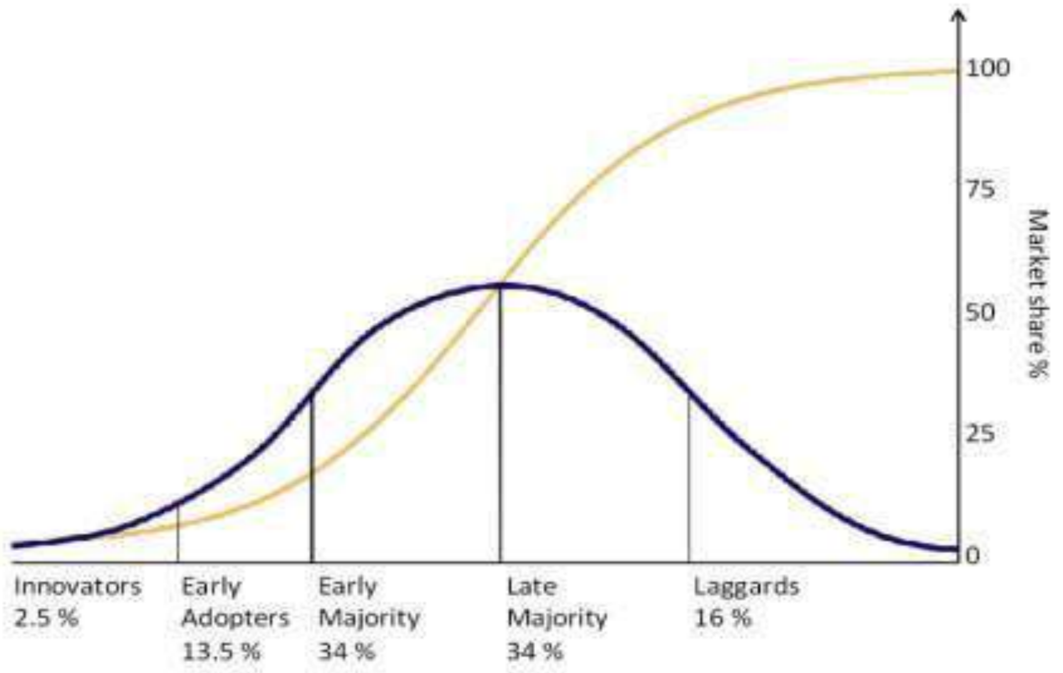


Figure. S-shaped diffusion curve

Figure Innovation adoption process.

Elaboration Likelihood Model . Developed by Petty and Cacioppo (1986), the elaboration likelihood model (ELM) is a dual-process theory of attitude formation or change in the psychology literature. It explains how individuals can be influenced to change their attitude toward a certain object, events, or behavior and the relative efficacy of such change strategies. The ELM posits that one’s attitude may be shaped by two “routes” of influence, the central route and the peripheral route, which differ in the amount of thoughtful information processing or “elaboration” required of people.

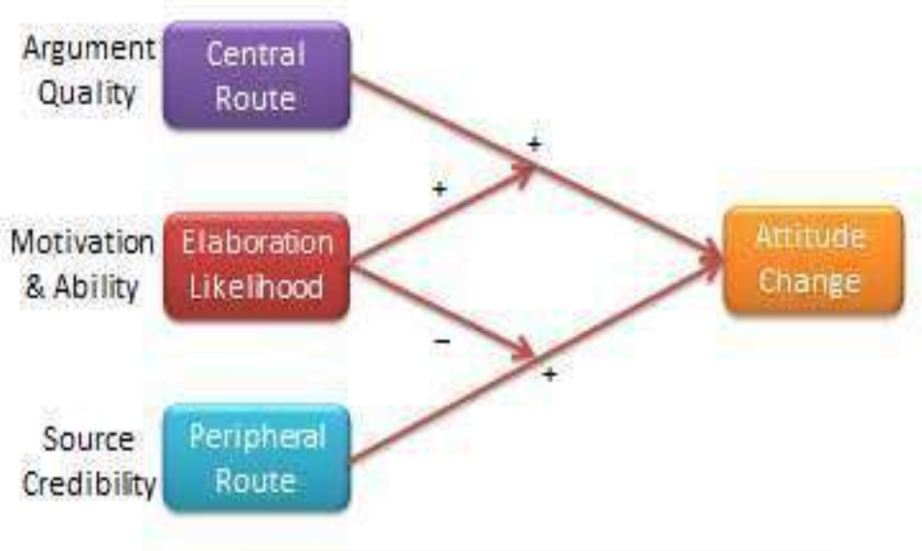


Figure. Elaboration likelihood model

The central route requires a person to think about issue-related arguments in an informational message and carefully scrutinize the merits and relevance of those arguments, before forming an informed judgment about the target object. In the peripheral route, subjects rely on external "cues" such as number of prior users, endorsements from experts, or likeability of the endorser, rather than on the quality of arguments, in framing their attitude towards the target object. The latter route is less cognitively demanding, and the routes of attitude change are typically operationalized in the ELM using the argument quality and peripheral cues constructs respectively.

TOPIC 4
METHODOLOGY AND TECHNOLOGY EXPERIMENTAL RESEARCH IN AGRONOMY AND PLANT PROTECTION

Plan

1. Features of scientific research in agronomy.
2. Stages of experimental studies.
3. Bio- horizons and their research.
4. Analysis biogeocenosis components and their interactions.
5. Analysis of the biological cycle of nutrients.

1. Features of scientific research in agronomy

What is an agricultural experiment? Within the agricultural sciences the answer to this question will vary among disciplines. The common features are a treatment, a hypothesized process or ausal mechanisms to be tested. Living creatures or parts thereof are usually the object of an experiment. Today, each branch of the agricultural sciences will have its manual or guidelines for experi-mentation, depending on the object of the experiment, the place where the experiment is done, the treatment or process that is tested and the methods used. The connection between agricultural experiments and agricultural science seems obvious. However, at the beginning of the 20th century, agricultural scientists were very much in doubt about the validity of the commonly used experi- mental approach. In recent years, anthropologists like Richards and others claim that many of the basic agricultural activities carried out by farmers are experimental in nature as well. Based on anthro-pological fieldwork among rice farmers in Sierra Leone, Richards in particular emphasized how farmers deal with the agro-ecological conditions as a performance. In farming practice, experimenta- tion is a crucial act to improve farming results in subsequent seasons. At first glance, the experiments by farmers look completely different from the scientific experiments performed on controlled experimental plots, often in climate-conditioned greenhouses. Experiments by (African) farmers and scientists seem as distinct as (Western) scientific knowledge and (non-Western) indigenous knowledge. However, Richards has pointed out that the principles of farmer experiments are basically the same as the principles of scientific experiments. For him, claims about fundamental distinctions between the cognitive processes underlying experiments of African farmers and knowledge produc-tion in (Western) science carry an “implicit notion of intellectual apartheid”. What makes agricultural experiments something different for farmers and agronomists is therefore not the capacity to experiment as such but the embedding of experiments in a specific ecological, material and institutional environment.

There are few studies that examine agricultural experiments as performed by agronomists or other agricultural scientists. The social science literature on scientific experiments more generally is much larger and this paper therefore first addresses some of the central features emerging from that literature and how this applies to experiments in agricultural science. In the following sections historical information is mobilized to show what devel-opments resulted in the displacement of agricultural experiments from the farmer's field to various other environments. The case of rice is of particular interest because initiatives to set up experi- ments for rice improvement were taken by administrators of the colonial government who were concerned about the food situa- tion on Java, Indonesia. During the late 1880s and 1890s, district officers located in different parts of this island were instructed to set up experiments with various cultivation methods to demon-strate to the local farmers how to grow rice more efficiently. These administrators had no training in agriculture, no experience with rice cultivation and, with few exceptions, never took it very seriously. Initially, when agricultural experts entered the scene there was little commitment to engage in rice farming. However, once agricultural advisors were appointed with a mandate to per-form on-farm experiments things started moving. Prompted by the advance in statistical inference calculation, the design and validity of the experiments became a controversial issue. It will be shown how a particular solution established by the late 1920s, resulted in a hierarchy of experiments held together by the bureaucracy of the agricultural research organization. In the decades that fol-lowed, a variety of factors resulted in an increasing differentiation of agricultural experiments. This differentiation had an impact on most agricultural research and extension services across the world and is still the dominant mode of operation today. The last section discusses some of the shortcomings of the current mode of agri-cultural experimentation. It is shown how recent work of Richards offers some suggestions for alternative ways of setting up experi-ments and how agricultural experimentation might be organized differently.

Agricultural experiments in the social science literature

Many forms of experiments can be classified as an agricultural experiment. Rather than making a list of all the appearances of agricultural experiments, the social science literature, in particu-lar the history and sociology of science, is used to highlight some of the common features and processes related to experimentation. In several studies the theory and practice of scientific experiments are examined. The overall message is that historically and socially determined factors play an important role in establishing what counts as a scientific experiment. The common association between experiments and laboratories, for example, is a feature of present-day science that is very different from the situation in the past. A common feature of all forms of experiment, in past and present, is demonstration. More specifically, there is a close connection between what experiments try to demonstrate and the public theywant to convince with the demonstration.

ExaminingtheactivitiesofRoyalSocietyFellowsin17thcentury England, the historian and sociologist of science Steven Shapin showed that most experiments were conducted in private houses. Other possible locations were a coffeehouse or the royal palace. More than a geographical space and material setting, these locations were demarcated by social regulations. "[A]ccess to most experimental venues (and especially those located in private residences) was obtained in a highly informal manner, through the tacit system of recognitions, rights, and expectations that operated in the wider society of gentlemen”. The location where experiments were done varied with the audience called in to be convinced as witness. A similar point emerges from Bruno Latour’s tudy of the discovery of an anthrax vaccine by the microbiologist Louis Pasteur. Not the discovery as such but the process of convincing veterinarians and livestock farmers, Latour argues, is what made Pasteur a great scientist. To accomplish this, Pasteur organized ‘staged demonstrations’ at the countryside in which hemanaged to replicate what he did in the laboratory.

Besides management of the audience, the objects and findings resulting from scientific experiments require alignment with the material environment outside the scientific experimental set-ting. The social studies on the role of laboratories in science make clear how relocation of a laboratory experiment in a real situation requires both physical and social adjustment in order to make clear that what works in the laboratory also works in society. Success in science implies optimized mobility of experimental results between the protected environment of a laboratory and the messy world outside. In particular for scientific fields that work on technical applications in a certain domain of society, careful adjustments of what works in a scientific experiment and what works in society is required. In other words, for experiments on new technical devices or modifications it is accuracy and reliability of the technical procedure or system that is tested.

Is there something special about experiments in the domain of the agricultural sciences? Although experiments in agricultural science have specific features, there is no reason to give it a special status or to assume that scientific agricultural experiments operate principally different from experiments in other scientific fields. Experimental practices might even become hard to recognize as ‘agricultural’ when research objects are taken out of their agricultural environments. An experimental setting of a molecular biology laboratory at an agricultural institute will look very much the same as the scenery of a molecular laboratory in medical research. Under laboratory conditions, experimental objects are often hard to recognize as organisms or simply invisible for the naked eye. It is interesting to explore how in agricultural science the linkages between experimental objects, organism and practice are made. The main features of scientific experiments emerging from social studies of science and technology are key elements in agricultural science as well. A point that can be added is the specific role of on-farm field trials in agricultural science. This type of experiment tries to establish a connection between experimental work at a research institute and the activities of farmers. However, on-farm field experiments not only take place at a specific place, they also have dynamics of their own. Field experiments therefore are not just a communication channel between science and practice but require particular knowledge and skills of the experimenter about setting up the experiments, materials to use and the involvement of farmers, technicians and other actors.

Agronomy

Agronomy is the science and technology of producing and using plants for food, fuel, fiber, and land reclamation. Agronomy has come to encompass work in the areas of plant genetics, plant physiology, meteorology, and soil science. It is the application of a combination of sciences like biology, chemistry, economics, ecology, earth science, and genetics. Agronomists of today are involved with many issues, including producing food, creating healthier food, managing the environmental impact of agriculture, and extracting energy from plants.[1] Agronomists often specialise in areas such as crop rotation, irrigation and drainage, plant breeding, plant physiology, soil classification, soil fertility, weed control, and insect and pest control.

Plant breeding

This area of agronomy involves selective breeding of plants to produce the best crops under various conditions. Plant breeding has increased crop yields and has improved the nutritional value of numerous crops, including corn, soybeans, and wheat. It has also led to the development of new types of plants. For example, a hybrid grain called triticale was produced by crossbreeding rye and wheat. Triticale contains more usableprotein than does either rye or wheat. Agronomy has also been instrumental in fruit and vegetable production research.

Biotechnology

Purdue University agronomy professor George Van Scoyoc explains the difference between forest and prairie soils to soldiers of the Indiana National Guard's AgribusinessDevelopment Team at the Beck Agricultural Center in West Lafayette, Indiana

Agronomists use biotechnology to extend and expedite the development of desired characteristic. Biotechnology is often a lab activity requiring field testing of the new crop varieties that are developed.

In addition to increasing crop yields agronomic biotechnology is increasingly being applied for novel uses other than food. For example, oilseed is at present used mainly for margarine and other food oils, but it can be modified to produce fatty acids for detergents, substitute fuels and petrochemicals.

Soil science

Agronomists study sustainable ways to make soils more productive and profitable throughout the world. They classify soils and analyze them to determine whether they contain nutrients vital to plant growth. Common macronutrients analyzed include compounds of nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. Soil is also assessed for several micronutrients, like zinc and boron. The percentage of organic matter, soilp H, and nutrient holding capacity (cation exchange capacity) are tested in a regional laboratory. Agronomists will interpret these lab reports and make recommendations to balance soil nutrients for optimal plant growth.

Soil conservation

In addition, agronomists develop methods to preserve the soil and to decrease the effects of erosion by wind and water. For example, a technique called contour plowing may be used to prevent soil erosion and conserve rainfall.

Researchers in agronomy also seek ways to use the soil more effectively in solving other problems. Such problems include the disposal of human and animal manure, water pollution, and pesticide build-up in the soil. As well as looking after the soil for future generations to come, such as the burning of paddocks after crop production. As well as pasture [management] Techniques include no-tilling crops, planting of soil-binding grasses along contours on steep slopes, and contour drains of depths up to 1 metre.

Agroecology

Agroecology is the management of agricultural systems with an emphasis on ecological and environmental perspectives. This area is closely associated with work in the areas ofsustainable agriculture, organic farming, and alternative food systems and the development of alternative cropping systems.

Theoretical modeling

Theoretical production ecology tries to quantitatively study the growth of crops. The plant is treated as a kind of biological factory, which processes light, carbon dioxide, water, andnutrients into harvestable products. The main parameters considered are temperature, sunlight, standing crop biomass, plant production distribution, and nutrient and water supply.

2. Stages of experimental studies

When you are involved in conducting a research project, you generally go through the steps described below, either formally or informally. Some of these are directly involved in designing the experiment to test the hypotheses required by the project. The following steps are generally used in conducting a research project.

1. Review pertinent literature to learn what has been done in the field and to become familiar enough with the field to allow you to discuss it with others. The best ideas often cross disciplines and species, so a broad approach is important.

2. Define your objectives and the hypotheses that you are going to test. You can't be vague. You must be specific. A good hypothesis is:

a. Clear enough to be tested

b. Adequate to explain the phenomenon

c. Good enough to permit further prediction

d. As simple as possible

3. Specify the population on which research is to be conducted. The types of experiments required to solve these problems vary greatly in scope and complexity and also in resource requirements.

4. Evaluate the feasibility of testing the hypothesis. One should be relatively certain that an experiment can be set up to adequately test the hypotheses with the available resources. Therefore, a list should be made of the costs, materials, personnel, equipment, etc., to be sure that adequate resources are available to carry out the research. If not, modifications will have to be made to design the research to fit the available resources.

5. Select Research Procedure:

a. Selection of treatment design is very crucial and can make the difference between success or failure in achieving the objectives. Should seek help of a statistical resource person (statistician) or of others more experienced in the field. Statistical help should be sought when planning an experiment rather than afterward when a statistician is expected to extract meaningful conclusions from a poorly designed experiment.

b. Selection of the sampling or experimental design and number of replicates. This is the major topic of this course so this will not be discussed further other than to comment that in general one should choose the simplest design that will provide the precision you require.

c. Selection of measurements to be taken. With the computer it is now possible to analyze large quantities of data and thus the researcher can gain considerably more information about the crop, etc. than just the effects of the imposed variables on yield. For example, with corn, are you going to measure just the yield of grain, or of ears, or of grain plus stover? What about days to tasseling and silking? Height of ears, kernel depth, kernel weight, etc. What about nutrient levels at tasseling, or weather conditions, especially if there are similar experiments at other locations having different climates?

d. Selection of the unit of observation, i.e., the individual plant, one row, or a whole plot, etc?

e. Control of border effects or effects of adjacent units on each other or "competition". Proper use of border rows or plants and randomization of treatments to the experimental units helps minimize border effects. Proper randomization of treatments to the experimental unit is also required by statistical theory so be sure this is properly done.

f. Probable results: Make an outline of pertinent summary tables and probable results. Using information gained in the literature review write out the results you expect. Essentially perform the experiment in theory and predict the results expected.

g. Make an outline of statistical analyses to be performed. Before you plant the first pot or plot or feed the first animal, you should have set up an outline of the statistical analysis of your experiment to determine whether or not you are able to test the factors you wish with the precision you desire. One of the best ways to do this is to write out the analysis of variance table (source of variation and df) and determine the appropriate error terms for testing the effects of interest. A cardinal rule is to be sure you can analyze the experiment yourself and will not require a statistician to do it for you--he might not be there when you need him. Another danger in this age of the computer and statistical programs, is to believe that you can just run the data through the statistical program and the data will be analyzed for you. While this is true to a certain extent, you must remember that the computer is a perfect idiot and does only what you tell it to do. Therefore, if you do not know what to tell the computer to do and/or of you don't know what the computer is doing, you may end up with a lot of useless output-garbage!! Also, there is the little matter of interpreting all the computer output that you can get in a very short time. This is your responsibility and you had better know what it is all about.

6. Selection of suitable measuring instruments and control of bias in data collection:

Measuring instruments should be sufficiently accurate for the precision required. Don't want a gram balance (scale) to weigh watermelons or sugarcane. Experimental procedure should be free of personal bias, i.e., if treatment effects must be graded (subjective evaluation) such as in herbicide, or disease control experiments, the treatments should be randomized and the grader should not know what treatment he is grading until after he has graded it. Have two people do the data collection, one grade and the other record

7. Install experiment: Care should be taken in measuring treatment materials (fertilizers, herbicides, or other chemicals, food rations, etc.) and the application of treatments to the experimental units. Errors here can have disastrous effects on the experimental results. In field experiments, you should personally check the bags of fertilizer or seed of varieties which should be placed on each plot, to be certain that the correct fertilizers or variety will be applied to the correct plot before any fertilizer is applied or any seed planted. Once fertilizer is applied to a plot, it generally cannot be removed easily. With laboratory experiments or preparation of various rations for feeding trials, check calculations and reagents or ingredients, etc., and set up a system of formulating the treatments to minimize the possibility of errors.

8. Collect Data: Careful measurements should be made with the appropriate instruments. It is better to collect too much data than not enough. Data should also be recorded properly in a permanent notebook. In many studies data collection can be quite rapid and before you know it you have data scattered in 6 notebooks, 3 folders, and 2 packs of paper towels!! When it is time to analyze the data, it is a formidable task, especially if someone has used the paper towels to dry their hands. Thus a little thought early in the experiment will save a lot of time and grief later. Avoid recording data on loose sheets at all costs as this is one good way to prolong your stay here by having to repeat experiments because the data were lost. Avoid fatigue in collecting data as errors increase as one gets tired. Also avoid recopying data as this is a major source of errors in experimental work. If data must be recopied, check figures against the originals immediately. It is better to have two people do the checking, one read the original data and the other read the copied data. When one person is making measurements and another recording, have the person recording repeat the value being recorded. This will minimize errors.

9. Make a complete analysis of the data: Be sure to have a plan of analysis, e.g., which analysis and in what order will they be done? Interpret the results in the light of the experimental conditions and hypotheses tested. Statistics do not prove anything and there is always the possibility that your conclusions may be wrong. One must consider the consequences of drawing an incorrect conclusion and modify the interpretation accordingly. Do not jump to a conclusion just because an effect is significant. This is especially so if the conclusion doesn't agree with previously established facts. The experimental data should be checked very carefully if this occurs, as the results must make sense!

10. Finally, prepare a complete, correct, and readable report of the experiment.

This may be a report to the farmer or researcher or an extension publication. There is no such thing as a negative result. If the null hypothesis is not rejected, it is positive evidence that there may be no real difference among the treatments tested. In summary, you should remember the 3 R's of experimentation:

1. Replicate: This provides a measure of variation (an error term) which is used in

evaluating the effects observed in the experiment. This is the only way that the validity of your conclusions from the experiment can be measured.

2. Randomize: Statistical theory requires the assignment of treatments to the experimental units in a purely random manner. This prevents bias.

3. Request Help: Ask for help when in doubt about how to design, execute or analyze your experiment. Not everyone is a statistician, but should know the important principles of scientific experimentation. Be on guard against common pitfalls and ask for help when you need it. Do this when planning an experiment, not after it is completed.

3. Biogeocenosis and their research

Biogeocenosis an interrelated complex of living and inert components associated with each other by material and energy exchange; one of the most complex systems in nature. Among the living components of the biogeocenosis are autotrophic organisms (photosynthesizing green plants and chemosynthesizing microorganisms) and heterotrophic organisms animals, ungi,many bacteria, and viruses), and among the inert components are the atmosphere layer around the earth, with its gas andthermal resources and solar energy; and the soil, with its water and mineral resources and, in part, the weathering crust (water in the ase of an aquatic biogeocenosis). Each biogeocenosis maintains both a uniformity (homogeneous, or moreoften mosaically homogeneous) of the composition and structure of its components and the character of the material andenergy exchange between them.

The higher and lower green plants, which provide the basic mass of living matter, play aparticularly important role in biogeocenoses. They produce the primary organic materials-the matter and energy that areused by the plants themselves and are transmitted along food chains to all heterotrophic organisms. Through the processesof photosynthesis and respiration, green plants maintain the balance of oxygen and carbon dioxide in the air; they participatein the circulation of water through transpiration. The death of organisms or their parts results in a biogenic migration andredistribution of food elements in the soil (N, P, K, Ca, and others). Finally, green plants directly or indirectly determine thecomposition and spatial location of animals and microorganisms in the biogeocenosis. The role of chemotrophicmicroorganisms in the biogeocenosis is less significant. In terms of the specific features of their activities, heterotrophs in abiogeocenosis can be divided into consumers, which transform and partially break down the organic matter of livingorganisms, and decomposers or destroyers (fungi, bacteria), which decompose compound organic substances in deadorganisms or their parts to simple mineral compounds. In all conversions the initially accumulated energy is lost and isdispersed in the form of heat in the surrounding space. In the functioning of a biogeocenosis, a great role is played by soilorganisms such as saprophages, which feed on the organic remains of dead plants; and also soil microorganisms (fungi andbacteria), which decompose and mineralize these remains. To a significant degree, the structure of the soil, the formation ofhumus, the content of nitrogen in the soil, the conversion of a number of mineral substances, and many other soil propertiesdepend upon their activity. Without the heterotrophs, the completion of the biological circulation of matter, the existence ofautotrophs, and the biogeocenosis itself would not be possible. The inert components of the biogeocenosis serve as asource of energy and primary materials (gases, water, and minerals). The material and energy exchange between thecomponents of the biogeocenosis is shown on the diagram of the biogeocenosis (according to A. A. Molchanov; the influxand consumption of energy are expressed in kilocalories per hectare).

4. Analysis biogeocenosis components and their interactions

The transition from one biogeocenotic process to another in space or time is accompanied by a change in the states andproperties of all its components, and consequently by a change in the nature of biogeocenotic metabolism. The boundariesof a biogeocenosis can be traced from many of its components, but more often they coincide with the boundaries of the plantcommunities (phytocenoses). The mass of the biogeocenosis is not homogeneous either in terms of composition or thestate of its components or in terms of the conditions and results of their biogeocenotic activity. This mass is differentiatedinto the aboveground, underground, and underwater parts which in turn are divided into elementary vertical structures—biogeohorizons, which are very specific in terms of composition, structure, and the state of the living and inert components.The concept of biogeocenotic parcels has been introduced to designate the horizontal heterogeneity or mosaic quality of abiogeocenosis. Like the biogeocenosis as a whole, this concept is a comprehensive one, since the vegetation, animals,microorganisms, soil, and atmosphere constitute the parcel in the capacity of participants in the exchange of matter andenergy.

A biogeocenosis is a dynamic system. Its continuous change and development is the result of the internal contradictorytendencies of its components. The changes in a biogeocenosis can be temporary, caused by easily reversible (daily,weather, and seasonal) reactions of the components in the biogeocenosis, or profound, leading to irreversible changes in thestate, structure, and general metabolism of the biogeocenosis and marking a change (succession) from one biogeocenosisto another. The changes can be slow or rapid; the latter often occur under the effect of sudden changes as a result of naturalcauses or the economic activity of man, who not only transforms and destroys the natural biogeocenoses, but also createsnew cultural ones. In addition to dynamic quality, biogeocenoses are also characterized by temporal stability, which iscaused by the fact that the modern natural biogeocenoses are the result Of a protracted and profound adaptation of the livingcomponents to each other and to the components of the inert environment. For this reason, biogeocenoses which have beenremoved from a stable state by one or another cause can be restored in a form close to the original after the elimination ofthis cause. Biogeocenoses similar in composition and structure of the components and in terms of metabolism and directionof development are classified in the same type of biogeocenosis; this is the basic unit of the biogeocenotic classification.The aggregate of biogeocenoses of the entire earth forms the biogeocenotic cover, or biogeosphere. A study ofbiogeocenoses and the biogeosphere constitutes the subject of the science of biogeocenology.

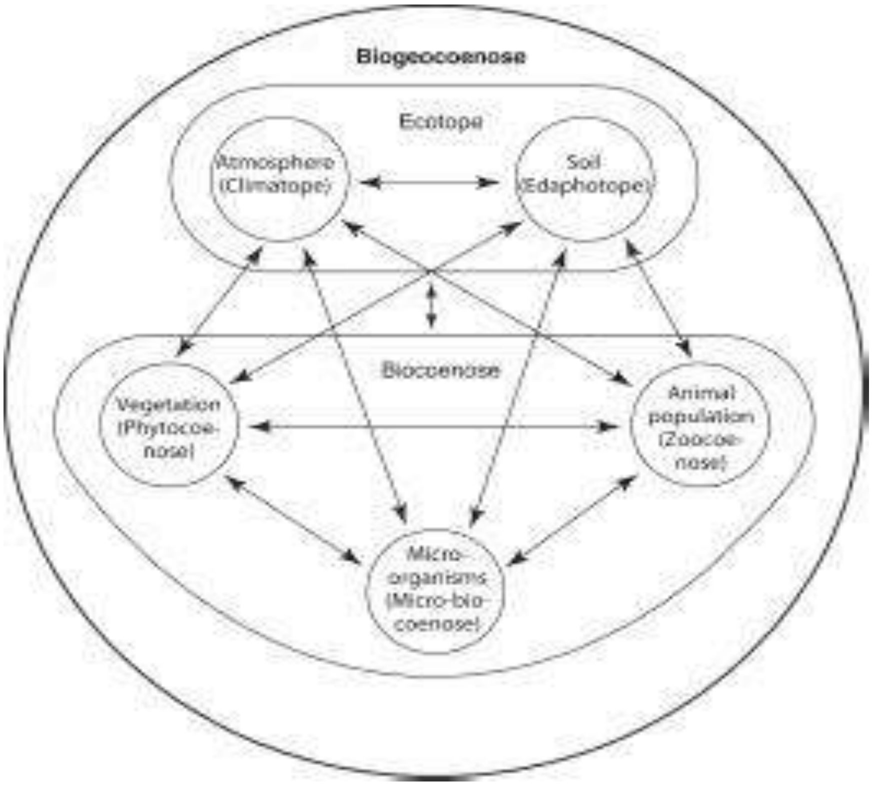


Figure. Diagram of a biogeocenosis

The concept of a biogeocenosis was introduced by V. N. Sukachev (1940). This was the logical development of the ideas ofthe Russian scientists V. V. Dokuchaev, G. F. Morozov, G. N. Vysotskii, and others concerning the relationships of livingand inert bodies of nature, as well as the ideas of V. I. Vernadskii concerning the planetary role of iving organisms. According to V. N. Sukachev, a biogeocenosis is close to the ecosystem of the English phytocenologist A.Tansley but differs by the definition of its content. A biogeocenosis is an elementary unit of the biogeosphere envisagedwithin the limits of specific plant communities, whereas an ecosystem is a dimensionless concept and can encompass aspace of any extent, from a drop of pond water to the biosphere as a whole.

The term “facies” is also used by physical geographers in a sense close to that of a biogeocenosis.

5. Analysis of the biological cycle of nutrients

A nutrient cycle refers to the movement and exchange of organic and inorganic matter back into the production of living matter. The process is regulated by the food web pathways previously presented, which decompose organic matter into inorganic nutrients. Nutrient cycles occur within ecosystems. Nutrient cycles that we will examine in this section include water, carbon, oxygen and nitrogen cycles.

Water cycle

Over two thirds of the Earth's surface is covered by water. It forms an important component of most life forms, with up to 70%70%

- **Evaporation**: Most water evaporates from the oceans, where water is found in highest abundance. However some evaporation also occurs from lakes, rivers, streams and following rain.
- **Transpiration**: Is the water loss from the surface area (particularly the stomata) of plants. Transpiration accounts for a massive 50%50%10%10%
- **Evapotranspiration**: The processes of evaporation and transpiration are often collectively referred to as evapotranspiration.
- **Condensation**: The process by which water vapour is converted back into liquid is called condensation. You may have observed a similar process occurring when dew drops form on a blade of grass or on cold glass. Water in the atmosphere condenses to form clouds.
- **Precipitation**: Water returns to Earth through precipitation in the form of rain, sleet, snow or ice (hail). When rain occurs due to precipitation, most of it runs off into lakes and rivers while a significant portion of it sinks into the ground.
- **Infiltration**: The process through which water sinks into the ground is known as infiltration and is determined by the soil or rock type through which water moves. During the process of sinking into the Earth's surface, water is filtered and purified. Depending on the soil type and the depth to which the water has sunk, the ground water becomes increasingly purified: the deeper the water, the cleaner it becomes.
- **Melting and freezing**: Some water freezes and is 'locked up' in ice, such as in glaciers and ice sheets. Similarly, water sometimes melts and is returned to oceans and seas.

The processes involved in the water cycle are shown in Figure.

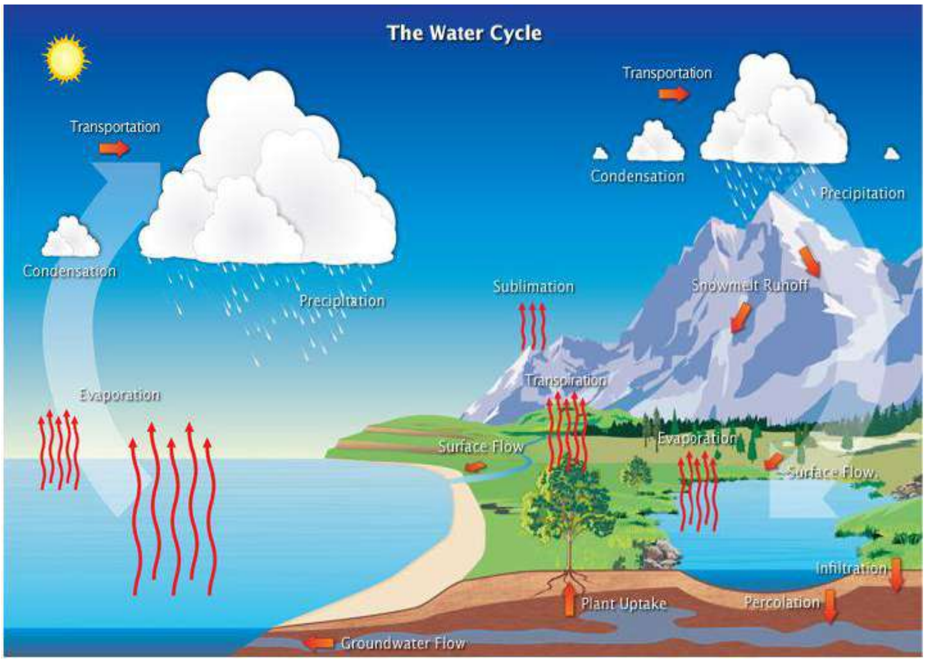


Figure: The water cycle

Oxygen cycle

Oxygen is one of the main gases found in the air, along with nitrogen. Oxygen is re-cycled between the air and living organisms in the following ways:

- **Breathing and respiration**: organisms such as animals and plants take in oxygen from the air during breathing and gaseous exchange processes. The oxygen is used for cellular respiration to release energy from organic nutrients such as glucose.
- **Photosynthesis**: during photosynthesis, plants absorb carbon dioxide from the air to synthesise sugars, and release oxygen.
- There is a **complementary** relationship between photosynthesis and cellular respiration in that the former produces oxygen and the latter consumes oxygen.

The oxygen cycle is shown in Figure.

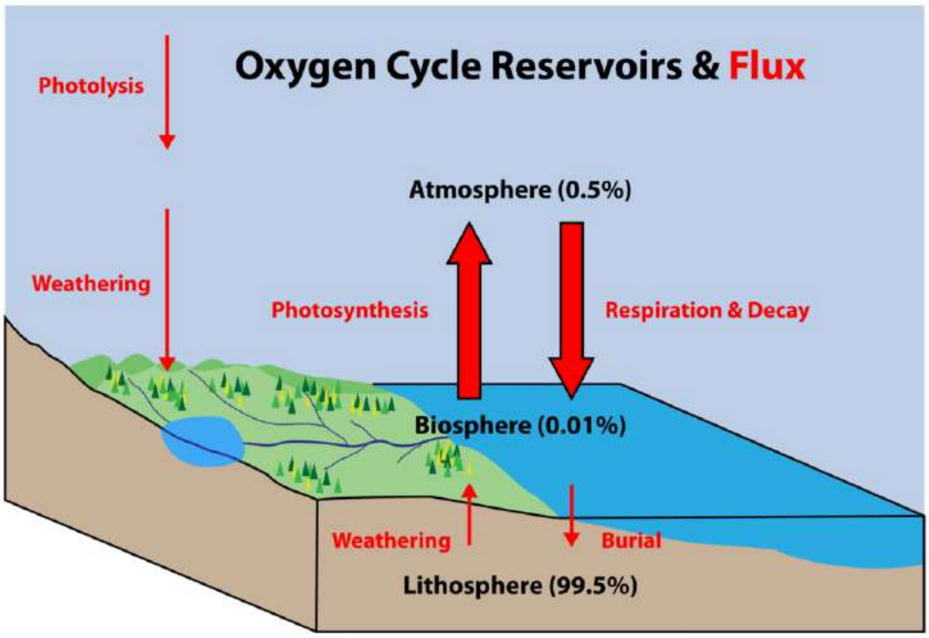


Figure: Oxygen cycle

Carbon cycle

Carbon is the basic building block of all **organic** materials, and therefore, of living organisms. Most of the carbon on earth can be found in the crust. Other reservoirs of carbon include the oceans and atmosphere.

Carbon moves from one reservoir to another by these processes:

- **Combustion**: Burning of wood and fossil fuels by factory and auto emissions transfers carbon to the atmosphere as carbon dioxide.
- **Photosynthesis**: Carbon dioxide is taken up by plants during photosynthesis and is converted into energy rich organic molecules, such as glucose, which contains carbon.
- **Metabolism**: Autotrophs convert carbon into *organic* molecules like fats, carbohydrates and proteins, which animals can eat.
- **Cellular respiration**: Animals eat plants for food, taking up the organic carbon (carbohydrates). Plants and animals break down these organic molecules during the process of cellular respiration and release energy, water and carbon dioxide. Carbon dioxide is returned to the atmosphere during gaseous exchange.
- **Precipitate**: Carbon dioxide in the atmosphere can also **precipitate** as carbonate in ocean sediments.
- **Decay**: Carbon dioxide gas is also released into the atmosphere during the decay of all organisms.

Photosynthesis and **gaseous exchange** are the main carbon cycling processes involving living organisms. Figure depicts the carbon cycle.

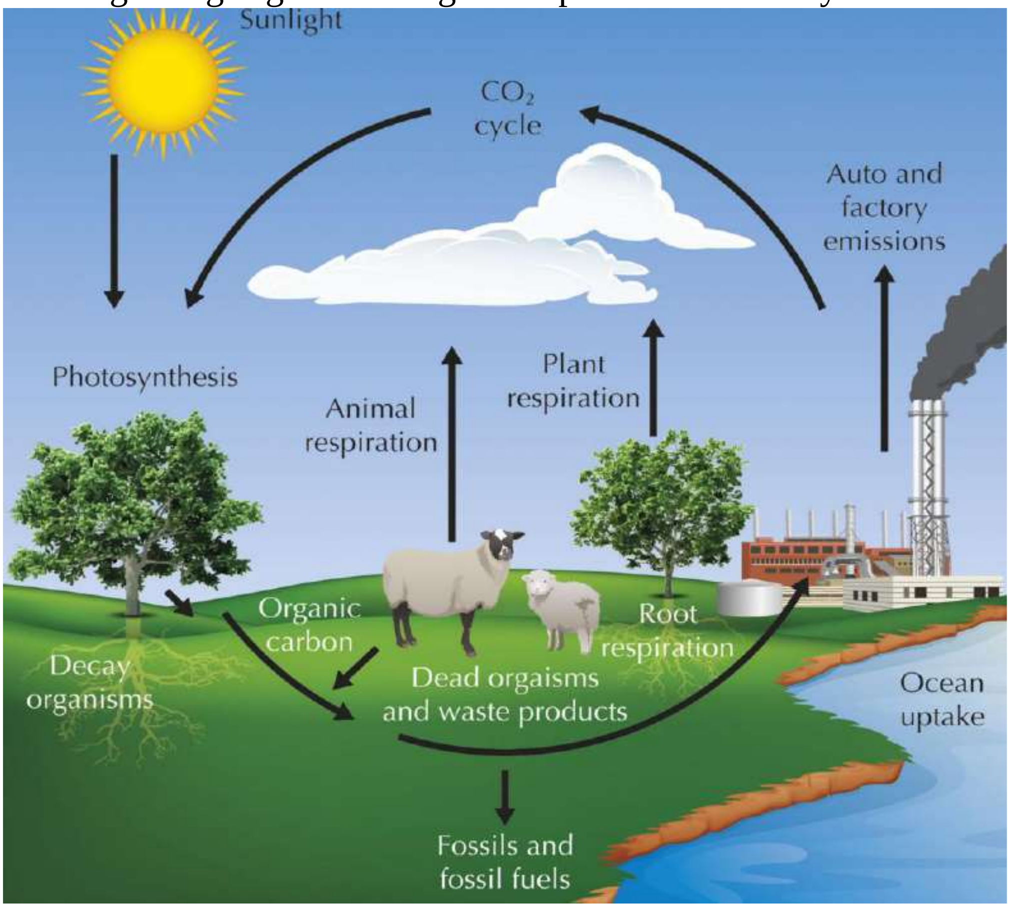


Figure: The carbon cycle

Nitrogen cycle

- Nitrogen gas present in the air is **not** available to organisms and thus has to be made available in a form absorbable by plants and animals.
- Only a few single-cell organisms, like bacteria can use nitrogen from the atmosphere directly.
- For plants, nitrogen has to be changed into other forms, eg. nitrates or ammonia. This process is known as nitrogen fixation.

The nitrogen cycle involves the following steps:

- **Lightning**: Nitrogen can be changed to nitrates directly by lightning. The rapid growth of algae after thunderstorms is because of this process, which increases the amount of nitrates that fall onto the earth in rain water, acting as fertiliser.
- **Absorption**: Ammonia and nitrates are absorbed by plants through their roots.
- **Ingestion**: Humans and animals get their nitrogen supplies by eating plants or plant-eating animals.
- **Decomposition**: During decomposition, bacteria and fungi break down proteins and amino acids from plants and animals.
- **Ammonification**: The nitrogenous breakdown products of amino acids are converted into ammonia by these decomposing bacteria.
- **Nitrification**: Is the conversion of the ammonia to nitrates by nitrifying bacteria.
- **Denitrification**: In a process called denitrification, bacteria convert ammonia and nitrate into nitrogen and nitrous oxide. Nitrogen is returned to the atmosphere to start the cycle over again.

The nitrogen cycle is shown in Figure.

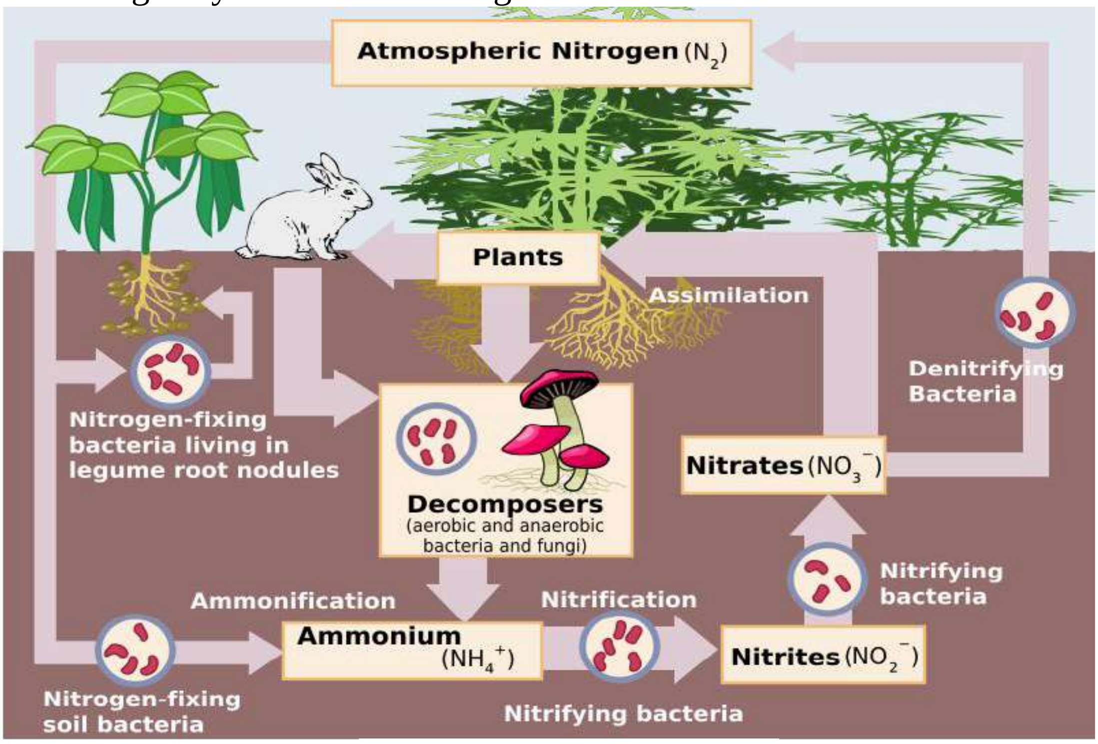


Figure: The nitrogen cycle

TOPIC 5
INFORMATION SUPPORT OF SCIENTIFIC RESEARCHES

Plan

1. Bibliographic and bibliographic sources of information.
2. Search information in information retrieval systems.
3. Technology of information gathering on research topics and work on scientific literature.
4. Receipt and analysis of primary information.
5. Computer processing of data.
6. Statistical Analysis.

1. Bibliographic and bibliographic sources of information

How to write a bibliography

A bibliography is not just "works cited." It is *all* the relevant material you drew upon to write the paper the reader holds.

Do I need a bibliography?

If you read any articles or books in preparing your paper, you need a bibliography or footnotes.

- If you cite the arguments of "critics" and "supporters," even if you don't name them or quote them directly, you are likely referring to information you read in books or articles as opposed to information you've gathered firsthand, like a news reporter, and so you need a bibliography.
- If you quote sources and put some of the reference information in the text, you still need a bibliography, so that readers can track down the source material for themselves.
- If you use footnotes to identify the source of your material or the authors of every quote, you DO NOT need a bibliography, UNLESS there are materials to which you do not refer directly (or if you refer to additional sections of the materials you already referenced) that also helped you reach your conclusions. In any event, your footnotes need to follow the formatting guidelines below.

2. Search information in information retrieval systems

Information retrieval (**IR**) is the activity of obtaining information system resources relevant to an information need from a collection of information resources. Searches can be based on full-text or other content-based indexing. Information retrieval is the science of searching for information in a document, searching for documents themselves, and also searching for metadata that describe data, and for databases of texts, images or sounds.

Automated information retrieval systems are used to reduce what has been called information overload. An IR system is a software that provide access to books, journals and other documents, stores them and manages the document. Web search engines are the most visible IR applications.

An information retrieval process begins when a user enters a query into the system. Queries are formal statements of information needs, for example search strings in web search engines. In information retrieval a query does not uniquely identify a single object in the collection. Instead, several objects may match the query, perhaps with different degrees of relevancy.

An object is an entity that is represented by information in a content collection or database. User queries are matched against the database information. However, as opposed to classical SQL queries of a database, in information retrieval the results returned may or may not match the query, so results are typically ranked. This ranking of results is a key difference of information retrieval searching compared to database searching.

Depending on the application the data objects may be, for example, text documents, images,audio, mind maps or videos. Often the documents themselves are not kept or stored directly in the IR system, but are instead represented in the system by document surrogates or metadata.

Most IR systems compute a numeric score on how well each object in the database matches the query, and rank the objects according to this value. The top ranking objects are then shown to the user. The process may then be iterated if the user wishes to refine the query.

3. Technology of information gathering on research topics and work on scientific literature

How to write a bibliography

These guidelines follow those of the American Psychological Association and may be slightly different than what you're used to, but we will stick with them for the sake of consistency.

Notice the use of punctuation. Publication titles may be either *italicized* or underlined, but not both.

Books

Books are the bibliography format with which you're probably most familiar. Books follow this pattern:

Author Last Name, Author First Name. (Publication Year) *Title*. Publisher's City: *Publisher. Page numbers.*

Alexander, Carol. (2001) *Market Models: A Guide to Financial Data Analysis.* New York, NY: John Wiley & Sons. pp. 200-220.

Periodicals

Periodicals remove the publisher city and name and add the title of the article and the volume or issue number of the periodical. Notice article titles are put in quotation marks and only the publication title is italicized or underlined.

Author Last Name, Author First Name. (Publication Date-could be more than a year) "Article Title."*Publication Title, Vol. #*. (Issue #), Page numbers.

Salman, William A. (July-August 1997) "How to Write a Great Business Plan." *Harvard Business Review* 74. pp. 98-108.

Web versions of printed material

Because web sources are time-sensitive, meaning that web content can change day by day, it is important to include the day of retrieval and the URL from which you quoted the material. You include this in a retrieval statement.

The format for online versions of print publications should basically follow the same format as above, meaning if you're referencing an online book, you should follow the book format with the addition of the retrieval statement. If you're referencing an online periodical, you should follow the periodical format with the addition of the retrieval statement.

Note that you should not break the Internet address of the link, even if it requires its own line. Very long URLs, such as those that occur when using an online database, can be shortened by removing the retrieval code. (The retrieval code usually consists of a long string of unintelligible letters and numbers following the end point "htm" or "html." Remove everything that occurs after that point to shorten.)

Author. (Date of Internet Publication-could be more than a year) "Document Title." *Title of Publication*. Retrieved on: Date from Full Web Address, starting with http://

How to cite sources in the text

In-text citations alert readers to cited material and tell them exactly where to go and look. These citations work in conjunction with a bibliography.

- Usually, an in-text citation is a combination of a name (usually the author's) and a number (either a year, a page number, or both).
- For Internet sources, use the original publication date, not your retrieval date.
- Internet sources also do not have page numbers, so use your discretion in the format that will direct the reader closest to the relevant section. You can number the paragraphs (abbreviate "par.") or chapters (abbreviate "chap.") or sections (abbreviate "sec.").
- If there is no author listed, the document's title should be used in place of the author's name. Use the entire title but not the subtitle. Subtitles are anything appearing after a colon (:).

Use a signal phrase

A signal phrase alerts the reader to the fact that you are citing another source for the information he or she is about to read.

Myers (1997) reported that "structured decision aids, as a factor in a more structured audit approach, are designed to focus the auditor on relevant information to improve effectiveness, and to improve audit efficiency, by eliminating the time needed to develop or organize individual approaches to the audit problems." (sec. 1, "Introduction")

Note that the date goes with the author, directions within the document go with the quote.

Later on, same source, different section:

According to one study (Myers, 1997), inexperienced auditors from a structured firm will demonstrate higher audit effectiveness in the typical audit situation than inexperienced auditors from an unstructured firm. (sec. 2, “Structure and Audit Effectiveness”)

Full parenthetical citation after the material cited

Another method is to end the quote with the full citation:

The primary controversies surrounding the issue of accounting for stock-based compensation include whether these instruments represent an expense that should be recognized in the income statement and, if so, when they should be recognized and how they should be measured. (Martin and Duchac, 1997, Sec. 3, “Theoretical Justification for Expense Recognition”)

For long quotes, use a previewing sentence and a parenthetical citation

Long quotes are 40 words or longer and should be single-spaced even in double-spaced papers. The previewing sentence tells the reader what to look for in the quotes (and helps the reader change gears from you to another author).

Martin and Duchac (1997) reiterate the problems with stock-based compensation and accounting issues:

While it is true these estimates generate uncertainties about value and the costs to be recognized, cost recognition should be the fundamental objective and information based on estimates can be useful just as it is with defined benefit pension plans.

Given the similarities between stock based compensation and defined benefit pension costs, an expense should be recognized for employee stock options just as pension costs are recognized for defined benefit pension plans. The FASB agreed with this assessment in their exposure draft on stock based compensation, noting that nonrecognition of employee stock option costs produces financial statements that are neither credible nor representationally faithful. (sec. 2.1, “Recognition of Compensation Cost”)

Note the consistent indentation and the paragraph break inside the quote. Also note that the parenthetical citation falls outside the closing period.

Source-reflective statements

Sometimes, summarizing arguments from your sources can leave the reader in doubt as to whose opinion he or she is seeing. If the language is too close to the original source’s, you can leave yourself open to charges of low-level plagiarism or “word borrowing.” Using a source-reflective statement can clarify this problem, allowing you the freedom to assert your voice and opinion without causing confusion. For example:

Myers (1997) reported that “structured decision aids, as a factor in a more structured audit approach, are designed to focus the auditor on relevant information to improve effectiveness, and to improve audit efficiency, by eliminating the time needed to develop or organize individual approaches to the audit problems.” (sec. 1, “Introduction”) Thus, audit pricing by firms with a structured audit approach is lower, on average, than firms with an intermediate or unstructured audit approach.

Is the observation in the last sentence Myers’s or the author’s? We aren’t sure. So insert a source-reflective statement to avoid confusion.

Myers (1997) reported that “structured decision aids, as a factor in a more structured audit approach, are designed to focus the auditor on relevant information to improve effectiveness, and to improve audit efficiency, by eliminating the time needed to develop or organize individual approaches to the audit problems.” (sec. 1, “Introduction”) *Myers’s observation suggests that* audit pricing by firms with a structured audit approach is lower, on average, than firms with an intermediate or unstructured audit approach.

When and how to use footnotes

You may decide to substitute footnotes for in-text citations and a bibliography. Footnotes are thorough, like entries in the bibliography, and yet specific, like in-text citations. However, depending on the thoroughness of your use of footnotes, you may also need a bibliography.

If you decide to use footnotes, you should follow the format outlined above for the information to include in your entries and should number each footnote separately (1, 2, 3, etc.). You should NOT use the same number twice, even when referencing the same document. Check out guidelines such as those in the *Chicago Manual of Style* or the *MLA Handbook* for more information about how to number your footnote entries.

A bibliography is a list of works on a subject or by an author that were used or consulted to write a research paper, book or article. It can also be referred to as a list of works cited. It is usually found at the end of a book, article or research paper.

Gathering Information

Regardless of what citation style is being used, there are key pieces of information that need to be collected in order to create the citation.

For books and/or journals:

- Author name
- Title of publication
- Article title (if using a journal)
- Date of publication
- Place of publication
- Publisher
- Volume number of a journal, magazine or encyclopedia
- Page number(s)

For websites:

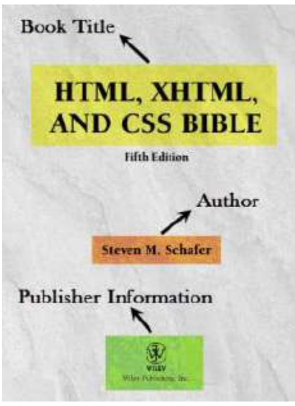
- Author and/or editor name
- Title of the website
- Company or organization that owns or posts to the website
- URL (website address)
- Date of access

This section provides two examples of the most common cited sources: a print book and an online journal retrieved from a research database.

Book - Print

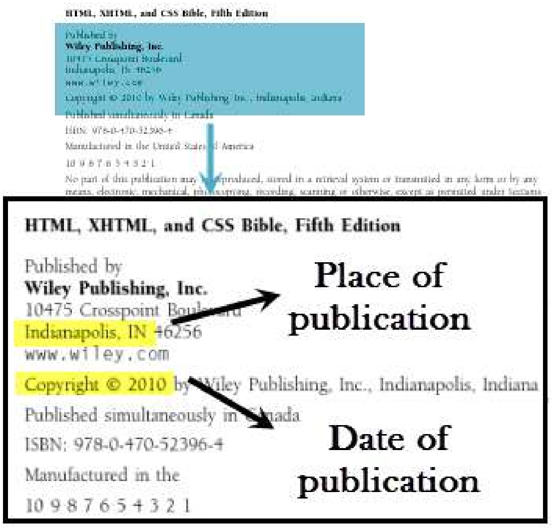
For print books, bibliographic information can be found on the **TITLE PAGE**. This page has the complete title of the book, author(s) and publication information.

The publisher information will vary according to the publisher - sometimes this page will include the name of the publisher, the place of publication and the date.



For this example:
Book title: HTML, XHTML, and CSS Bible
Author: Steven M. Schafer
Publisher: Wiley Publications, Inc.

If you cannot find the place or date of publication on the title page, refer to the **COPYRIGHT PAGE** for this information. The copyright page is the page behind the title page, usually written in a small font, it carries the copyright notice, edition information, publication information, printing history, cataloging data, and the ISBN number.



For this example:
Place of publication: Indianapolis, IN
Date of publication: 2010

Article - Academic OneFile Database

In the article view:

Bibliographic information can be found under the article title, at the top of the page. The information provided in this area is **NOT** formatted according to any style.

Title:
Skepticism & the architecture of trust

Author(s): Douglas Allchin

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Meteorological factors and El Niño Southern Oscillation are independently associated with dengue infections
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4. Receipt and analysis of primary information

Primary Sources

A primary source provides direct or firsthand evidence about an event, object, person, or work of art. Primary sources provide the original materials on which other research is based and enable students and other researchers to get as close as possible to what actually happened during a particular event or time period. Published materials can be viewed as primary resources if they come from the time period that is being discussed, and were written or produced by someone with firsthand experience of the event. Often primary sources reflect the individual viewpoint of a participant or observer. Primary sources can be written or non-written (sound, pictures, artifacts, etc.). In scientific research, primary sources present original thinking, report on discoveries, or share new information.

Examples of primary sources:

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Diaries, personal letters, and correspondence
Interviews, surveys, and fieldwork
Internet communications on email, blogs, listservs, and newsgroups
Photographs, drawings, and posters
Works of art and literature
Books, magazine and newspaper articles and ads published at the time
Public opinion polls
Speeches and oral histories

Original documents (birth certificates, property deeds, trial transcripts)
Research data, such as census statistics
Official and unofficial records of organizations and government agencies
Artifacts of all kinds, such as tools, coins, clothing, furniture, etc.
Audio recordings, DVDs, and video recordings
Government documents (reports, bills, proclamations, hearings, etc.)
Patents
Technical reports
Scientific journal articles reporting experimental research results

Secondary Sources

Secondary sources describe, discuss, interpret, comment upon, analyze, evaluate, summarize, and process primary sources. A secondary source is generally one or more steps removed from the event or time period and are written or produced after the fact with the benefit of hindsight. Secondary sources often lack the freshness and immediacy of the original material. On occasion, secondary sources will collect, organize, and repackage primary source information to increase usability and speed of delivery, such as an online encyclopedia. Like primary sources, secondary materials can be written or non-written (sound, pictures, movies, etc.).

Examples of secondary sources:

Bibliographies
Biographical works
Reference books, including dictionaries, encyclopedias, and atlases
Articles from magazines, journals, and newspapers after the event
Literature reviews and review articles (e.g., movie reviews, book reviews)
History books and other popular or scholarly books
Works of criticism and interpretation
Commentaries and treatises
Textbooks
Indexes and abstracts

5. Computer processing of data

Data processing, Manipulation of data by a computer. It includes the conversion of raw data to machine-readable form, flow of data through the CPU and memory to output devices, and formatting or transformation of output. Any use of computers to perform defined operations on data can be included under data processing. In the commercial world, data processing refers to the processing of data required to run organizations and businesses.

***Data procesing* refers to the transformating raw data into meaningful output.**

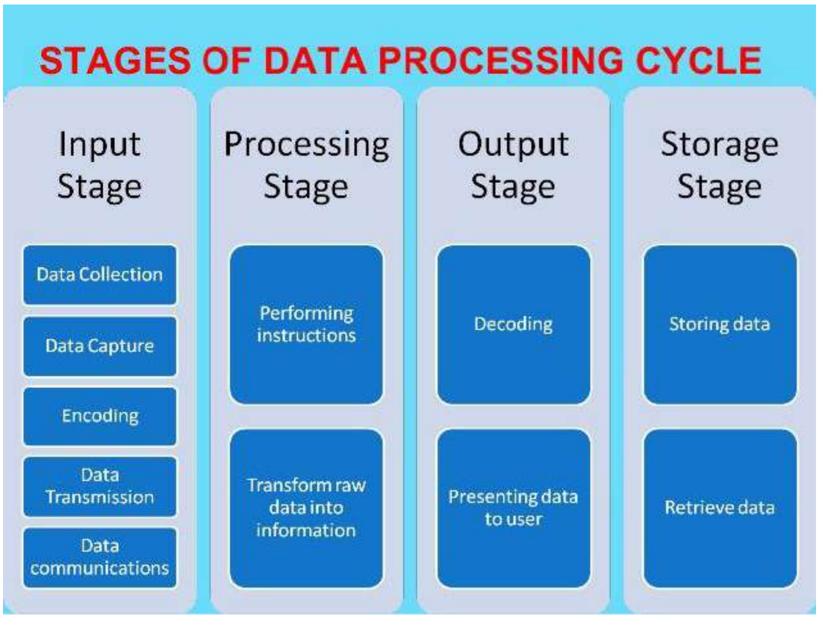
Data can be done manually using a pen and paper, mechanically using simple devices eg typewritter or electronically using modern dat processing toolseg computers

Data collection involves getting the data/facts needed for processing from the point of its origin to the computer

Data Input- the collected data is converted into machine-readable form by an input device, and send into the machine.

Processing is the transformation of the input data to a more meaningful form (information) in the CPU

Output is the production of the required information, which may be input in future.



The difference between data collection and data capture.

Data capture is the process of obtaining data in a computer-sensible form for at the point of origin (the source document itself is prepared in a machine-sensible form for input)

Data collection involves getting the original data to the 'processing centre', transcribing it, converting it from one medium to another, and finally getting it into the computer.

Relevance of the term garbage in garbage out (GIGO) in reference to errors in data processing.

The accuracy of the data entered in the computer directly determines the accuracy of the information given out.

Give and explain two transcription and two computational errors committed during data processing.

Misreading errors: -they occur when the user reads source document incorrectly, thus entering wrong values, e.g. a user may confuse 5 in the number 586 with S, and type S86 instead.

Transposition errors: - they result from incorrect arrangement of characters (i.e., putting characters in the wrong order especially when keying data onto a diskette), e.g. the user may enter 396 instead of 369 **computational errors**

Overflow errors: -An overflow occurs if the result from a calculation is too large to fit in the allocated memory space, e.g., if the allocated memory space is able to store an 8-bit character, then an overflow will occur if the result of the calculation gives a 9-bit number.

- Underflow
- Truncation: 0.784969 784
- Rounding error:30.6666 7
- Algorithm or ,logical errors

Data integrity.

Data integrity refers to the dependability, timeliness, availability, relevance, accuracy & completeness of data/information

Threats to data integrity

Data integrity may be compromised through:

- Human error, whether malicious or unintentional.
- Transfer errors, including unintended alterations or data compromise during transfer from one device to another.
- Bugs, viruses/malware, hacking, and other cyber threats.
- Compromised hardware, such as a device or disk crash.

Ways of minimizing threats to data integrity.

- **Backing up the data on external storage media**
- **Enforcing security measures to control access to data**
- **Using error detection & correction software when transmitting data**
- **Designing user interfaces that minimize chances of invalid data being entered.**

Data processing methods

1. Manual Data Processing

In ***manual data processing***, data is processed manually without using any machine or tool to get required results. In manual data processing, all the calculations and logical operations are performed manually on the data. Similarly, data is transferred manually from one place to another. This method of data processing is very slow and errors may occur in the output. Mostly, is processed manually in many small business firms as well as government offices & institutions. In an educational institute, for example, marks sheets, fee receipts, and other financial calculations (or transactions) are performed by hand. This method is avoided as far as possible because of the very high probability of error, labor intensive and very time consuming. This type of data processing forms the very primitive stage when technology was not available or it was not affordable. With the advancement in technology the dependency on manual methods has drastically decreased.

2. Mechanical Data Processing

In ***mechanical data processing*** method, data is processed by using different devices like typewriters, mechanical printers or other mechanical devices. This method of data processing is faster and more accurate than manual data processing. These are faster than the manual mode but still forms the early stages of data processing. With invention and evolution of more complex machines with better computing power this type of processing also started fading away. Examination boards and printing press use mechanical data processing devices frequently.

3. Electronic Data Processing

Electronic data processing or EDP is the modern technique to process data. The data is processed through computer; Data and set of instructions are given to the computer as input and the computer automatically processes the data according to the given set of instructions. The computer is also known as electronic data processing machine.

This method of processing data is very fast and accurate. For example, in a computerized education environment results of students are prepared through computer; in banks, accounts of customers are maintained (or processed) through computers etc.

a**. Batch Processing**

Batch Processing is a method where the information to be organized is sorted into groups to allow for efficient and sequential processing. OnlineProcessing is a method that utilizes Internet connections and equipment directly attached to a computer. It is used mainly for information recording and research. Real-Time Processing is a technique that has the ability to respond almost immediately to various signals in order to acquire and process information. Distributed Processing is commonly utilized by remote workstations connected to one big central workstation or server. ATMs are good examples of this data processing method.

b. Online Processing

This is a method that utilizes Internet connections and equipment directly attached to a computer. This allows for the data stored in one place and being used at altogether different place. Cloud computing can be considered as a example which uses this type of processing. It is used mainly for information recording and research.

c. Real-Time Processing

This technique has the ability to respond almost immediately to various signals in order to acquire and process information. These involve high maintainance andupfront cost attributed to very advanced technology and computing power. Time saved is maximum in this case as the output is seen in real time. For example in banking transactions.

Example of real time processing

- Airline reservation systems
- Theatre (cinema) booking
- Hotel reservations
- Banking systems
- Police enquiry systems
- Chemical processing plants
- Hospitals to monitor the progress of a patient
- Missile control systems

Advantages

- Provides up-to-date information
- The information is readily available for instant decision-making
- Provides better services to users/customers.
- Fast &reliable

- Reduces circulation of hardcopies.

Disadvantages

- Require complex Os & are very expensive
- Not easy to develop
- Real time systems usually use 2 or more processors to share the workloads, which is expensive.
- Require large communication equipment.

d. Distributed Processing

This method is commonly utilized by remote workstations connected to one big central workstation or server. ATMs are good examples of this data processing method. All the end machines run on a fixed software located at a particular place and makes use of exactly same information and sets of instruction.

The Differentiate between CPU bound jobs and I/O bound jobs.

CPU bound jobs require more of the CPU time to process these jobs. Most of the work the I/O devices perform is on the Input; and Output; hence, they require very little CPU time.

Most companies are now shifting from the use of geographically distributed personal computers. This method of data processing is known as **Distributed Data Processing (DDP)**

Three computing resources that can be distributed.

-CPU (Processors) time
-Files
-Application software
-Data/information/messages
-Computer processing power
-Memory (computer storage)
- Input/Output devices, e.g. printers
-communication devices/communication port

Examples of industries and business organizations that extensively use distributed processing systems.

- Banks
- Computerized retails stores, e.g. supermarkets
- Learning institutions with many departmental offices
- Bureaus or communication cyber cafes
- Airline reservation systems

Benefits and three risks that might be associated with the distributed data Processing system.

The load on the host computer is greatly reduced

- The use of low cost minicomputers minimizes the cost in data processing
- Delays in data processing are reduced
- Provides better services to the customers
- There is less risk in case of system breakdown
- The design & implementation of the system is less complex due to decentralization

- The level of expertise required is less.

Risks

- Data duplication is very common
- Programming problems occur with microcomputers & minicomputers
- Security threats, i.e. the data & information sent one the network from one place to
- another can be tapped, or listened to by unauthorized parties
- More training is needed for the users involved
- It is expensive due to the extra cost of communication equipment.

The concept of multi-programming

A Multi-programming system allows the user to run 2 or more programs, all of which are in the computer's main memory, at the same time.

Benefits that are derived from multi-programming

- It increases productivity of a computer
- Reduces the CPU's idle time
- Reduces the incidence of peripheral bound operation

Advantages of storing data in computer files over the manual filing system

- Stored information takes up less space
- Easier to update and modify
- Provides faster access and retrieval of data
- Reduces duplication of data or stored records
- Cheaper
- Enhances data integrity (i.e. accuracy and completeness)

The difference between logical and physical computer files.

A logical file is viewed in terms of what data items it contains and what processing operations may be performed on the data

A physical file is viewed in terms of how the data items found in a file are arranged on the storage media and how they can be processed.

Arrange the following components of the information system data hierarchy in ascending order of complexity:

Field, Database, Byte, Record, Bit, and file

Bit Byte Field Record File Database

TYPES OF COMPUTER FILES

i) **Report file-** It contains a set of relatively permanent records extracted from the data in a master file.

They are used to prepare reports, which can ve printed at a later date, e.g. report on student's class performance in the term, extract of students who have not cleared their school fees, report on absentees

ii) **Backup file-** Used to backup data or to hold duplicate copies of data/information from the computer's fixed storage or main file for security purposes e.g. a copy of all the students admitted in a school fees, report on absentees

iii) **Reference file** - Used for reference purposes. It contains records that are fairly permanent or semi-permanent, e.g. Deductions in caution money, wage rates, tax deductions, employees address, price lists etc.

iv) Sort file – used to sort/rank data according to a given order, e.g. ranking position in a class of students.

v) Transaction file - Is used to hold input data during transaction processing. It is later used to update master files and audits daily, weekly or monthly transaction.

FILE ORGANISATION METHODS

What is file organization?

1. It is the way records are arranged (laid out) within a particular file or any secondary storage device in a computer
2. Refers to the way data is stored in a file
3. File organization is important because it determines the method of access, efficiency, flexibility and storage devices to be used.

Methods of file organization

i) Sequential and serial

*In **sequential** file organization*, records are stored in a sorted order using a key field, while in ***serial*;** the records are stored in the order they come into the file, and are not sorted in any way.

ii) Random and indexed-sequential

In *random file organization*, records are stored in the file randomly and accessed directly, while in *indexed –sequential*, the records are stored sequentially but accessed directly using an index.

iii) s**erial file organization**

Records are in a file are stored and accessed one after another on a storage medium

iv) Indexed sequencial file organization method

Similar to sequential method, only that an index is used to enable the computer to locate individual records on the storage media.

ELECTRONIC DATA PROCESSING MODES

This is the ways in which a computer under the influence of an operating system is designed to process data eg

a) Batch processing is the execution of a series of jobs in a program on a computer without manual intervention (non-interactive). Strictly speaking, it is a processing mode: the execution of a series of programs each on a set or "batch" of inputs, rather than a *single* input (which would instead be a custom *job*). However, this distinction has largely been lost, and the series of steps in a batch process are often called a "job" or "batch job".

Batch processing has these benefits:=

- It can shift the time of job processing to when the computing resources are less busy.
- It avoids idling the computing resources with minute-by-minute manual intervention and supervision.

- By keeping high overall rate of utilization, it amortizes the computer, especially an expensive one.
- It allows the system to use different priorities for interactive and non-interactive work.
- Rather than running one program multiple times to process one transaction each time, batch processes will run the program only once for many transactions, reducing system overhead.

Disadvantages

- Users are unable to terminate a process during execution, and have to wait until execution completes.

6. Statistical Analysis

Identifying Patterns

More advanced statistical analysis aims to identify patterns in data, for example, whether there is a link between two variables, or whether certain groups are more likely to show certain attributes.

This is in order to draw lessons from the sample that can be generalised to the wider population.

For more on making sure that your sample is large enough to allow you to generalise, see our page on Samples and Sample Design**.**

Relationships vs Differences

Research hypotheses can be expressed in terms of differences between groups, or relationships between variables. However, these are two sides of the same coin: almost any hypothesis could be set out in either way.

For example:

There is a relationship between gender and liking ice cream OR

Men are more likely to like ice cream than women.

Comparing Groups

Your first step is to identify your two or more groups. This will obviously depend on your research question or hypothesis.

So if your hypothesis was that men are more likely to like ice cream than women, your two groups are men and women, and your data is likely to be something like self-expressed liking for ice cream on a scale of 1 to 5, or perhaps the number of times that ice creams are consumed each week in the summer months.

You then need to produce summary data for each group, usually mean and standard deviation. These may or may not look quite similar.

In order to decide whether there is a genuine difference between the two groups, you have to use a **reference distribution** against which to measure the values from the two groups.

The most common source of reference distributions is a standard distribution such as the normal distribution or *t*- distribution. These two are the same except that the standard deviation of the *t*-distribution is estimated from the sample, and that of the normal distribution is known.

You then compare the summary data from the two groups and decide the probability of achieving that difference by chance. The lower the probability, the more likely it is that your result is correct. This is referred to as **statistical significance.**

Types of Error

There are four possible outcomes from statistical testing:

- The groups are different, and you conclude that they are different (correct result)
- The groups are different, but you conclude that they are not (Type II error)
- The groups are the same, but you conclude that they are different (Type I error)
- The groups are the same, and you conclude that they are the same (correct result).

Type I errors are generally considered more important than Type II, because they have the potential to change the status quo.

For example, if you wrongly conclude that a new medical treatment is effective, doctors are likely to move to providing that treatment. Patients may receive the treatment instead of an alternative that could have fewer side effects, and pharmaceutical companies may stop looking for an alternative treatment.

Choosing the Right Test

The test that you use to compare your groups will depend on how many groups you have, the type of data that you have collected, and also how good it is. In general, different tests are used for comparing two groups, and for comparing three or more.

One- or Two-Tailed Test

The other thing that you have to decide is whether you are confident of the direction of the distance. In practice, this boils down to whether your research hypothesis is expressed as ‘x is likely to be more than y’, or ‘x is likely to be different from y’. If you are confident of the direction of the distance, then your test will be **one-tailed.** If not, it will be **two-tailed**.

Calculating the Test Statistic

For each type of test, there is a standard formula for the test statistic. For example, for the *t*-test, it is:

(M1-M2)/SE(diff)

M1 is the mean of the first group

M2 is the mean of the second group

SE (diff) is the standard error of the difference, which is calculated from the standard deviation and the sample size of each group.

The final part of the test is to compare the test statistic to that required to meet the desired level of significance (usually 5% or 1%). This value is available from published statistical tables. If the test statistic is that value or more, then the difference between groups is said to be statistically significant at the 5% or 1% level.

NOTE: the significance level is sometimes called the *p* value, and expressed as $p < 0.05$ or $p < 0.01$.

Comparing Variables

Sometimes, you may want to know if there is a link between two variables. If so, you can predict someone's response to one variable by their response to the other.

- A **positive association** means that high scores for one variable tend to occur with high scores for the other.
- A **negative association** means that high scores for one variable tend to occur with low scores for the other.
- There is **no association** when the score for one variable does not predict the score for the other.

Such associations are also called **correlations**.

Seeing an Association

One of the best ways of checking for an association is to draw a line graph of the data with the two variables on the x and y axes. Broadly speaking, if there is an association, you will see it from the graph.

Drawing a graph will also help you identify if there is a peculiar relationship, such as a positive association for part of the data and a negative for the rest, as shown below. This will show in a test as no correlation, but there is clearly some sort of a relationship in this case.

Statistical Tests for Associations

Again, there are specific tests depending on whether you are using continuous, categorical or ranked data.

- For categorical data, you use the **chi-squared test** (also written χ^2)
- For continuous data it is the **Pearson product-moment correlation**
- For ranks, use the **Kendall rank order correlation**.

Again, you need to work out the test statistic, and compare that with the value needed to obtain the desired level of significance.

Warning! The Difference Between Correlation and Causation

A correlation is an association between two variables. It does not necessarily imply that one causes the other. Both could be caused by something completely different, or it could simply be that people who show one characteristic often show the other.

For example, it could be that people who shop for groceries online buy more ready-made meals than those who shop in store. However, it is unlikely that the act of buying online causes the purchase of more ready-meals. It is more likely that those who shop online are short of time, and so buy more convenience food, or possibly simply that younger people are both more likely to shop online and more likely to buy convenience food.

A Word of Advice

There are statistical packages available, such as SPSS, which will carry out all these tests for you. However, if you have never studied statistics, and you're not very confident about what you're doing, you are probably best off discussing it with a statistician or consulting a detailed statistical textbook.

Badly-done statistical analysis can invalidate very good research. It is much better to find someone to help you.

SIMPLE STATISTICAL ANALYSIS

Once you have collected quantitative data, you will have a lot of numbers. It's now time to carry out some statistical analysis to make sense of, and draw some inferences from, your data.

There is a wide range of possible techniques that you can use.

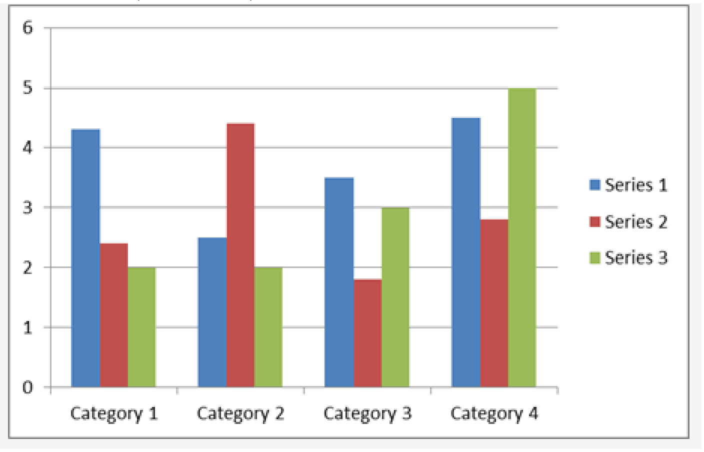
Summarising Data: Grouping and Visualising

The first thing to do with any data is to summarise it, which means to present it in a way that best tells the story.

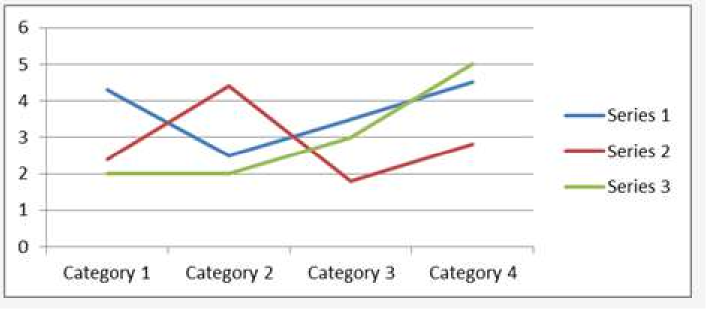
The starting point is usually to group the raw data into categories, and/or to visualise it. For example, if you think you may be interested in differences by age, the first thing to do is probably to group your data in age categories, perhaps ten- or five-year chunks.

One of the most common techniques used for summarising is using graphs, particularly bar charts, which show every data point in order, or histograms, which are bar charts grouped into broader categories.

An example is shown below, which uses three sets of data, grouped by four categories. This might, for example, be men, women, and 'no gender specified', grouped by age categories 20–29, 30–39, 40–49 and 50–59.



An alternative to a histogram is a **line chart**, which plots each data point and joins them up with a line. The same data as in the bar chart are displayed in a line graph below.



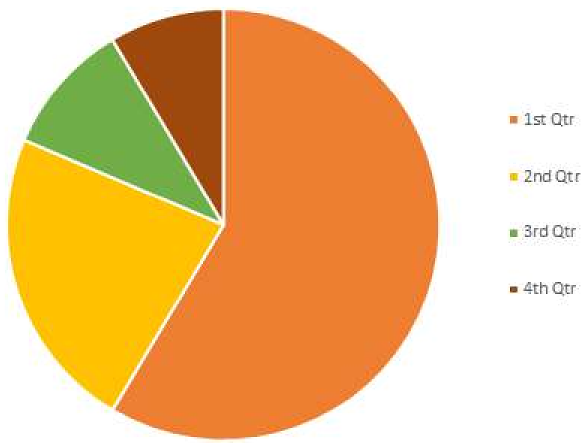
It is not hard to draw a histogram or a line graph by hand, as you may remember from school, but spreadsheets will draw one quickly and easily once you have input the data into a table, saving you any trouble. They will even walk you through the process.

Visualise Your Data

The important thing about drawing a graph is that it gives you an immediate 'picture' of the data. This is important because it shows you straight away whether your data are grouped together, spread about, tending towards high or low values, or clustered around a central point. It will also show you whether you have any 'outliers', that is, very high or very low data values, which you may want to exclude from the analysis, or at least revisit to check that they are correct.

It is always worth drawing a graph before you start any further analysis, just to have a look at your data.

You can also display grouped data in a **pie chart**, such as this one.



Pie charts are best used when you are interested in the relative size of each group, and what proportion of the total fits into each category, as they illustrate very clearly which groups are bigger.

Measures of Location: Averages

The **average** gives you information about the size of the effect of whatever you are testing, in other words, whether it is large or small. There are three measures of average: mean, median and mode.

When most people say average, they are talking about the **mean**. It has the advantage that it uses all the data values obtained and can be used for further statistical analysis. However, it can be skewed by 'outliers', values which are atypically large or small.

As a result, researchers sometimes use the **median** instead. This is the mid-point of all the data. The median is not skewed by extreme values, but it is harder to use for further statistical analysis.

The **mode** is the most common value in a data set. It cannot be used for further statistical analysis.

The values of mean, median and mode are **not** the same, which is why it is really important to be clear which 'average' you are talking about.

Measures of Spread: Range, Variance and Standard Deviation

Researchers often want to look at the **spread** of the data, that is, how widely the data are spread across the whole possible measurement scale.

There are three measures which are often used for this:

The **range** is the difference between the largest and smallest values. Researchers often quote the **interquartile range**, which is the range of the middle half of the data, from 25%, the lower quartile, up to 75%, the upper quartile, of the values (the median is the 50% value). To find the quartiles, use the same procedure as for the median, but take the quarter- and three-quarter-point instead of the mid-point.

The **standard deviation** measures the average spread around the mean, and therefore gives a sense of the 'typical' distance from the mean.

The **variance** is the square of the standard deviation. They are calculated by:

1. calculating the difference of each value from the mean;
2. squaring each one (to eliminate any difference between those above and below the mean);
3. summing the squared differences;
4. dividing by the number of items minus one.

This gives the **variance**.

To calculate the **standard deviation**, take the square root of the variance.

Skew

The **skew** measures how symmetrical the data set is, or whether it has more high values, or more low values. A sample with more low values is described as negatively skewed and a sample with more high values as positively skewed.

Generally speaking, the more skewed the sample, the less the mean, median and mode will coincide.

More Advanced Analysis

Once you have calculated some basic values of **location**, such as mean or median, **spread**, such as range and variance, and established the level of **skew**, you can move to more advanced statistical analysis, and start to look for patterns in the data.

MULTIVARIATE ANALYSIS

In real life, as opposed to laboratory research, you are likely to find that your data are affected by many things other than the variable that you wish to test. There are correlations between items that you've never considered, and the world is complex.

The purpose of advanced statistical analysis is to simplify some of the relationships, while making a more effective model of what you are seeing.

There are Four Ways to Simplify Analysis

- Design
- Using Sub-Samples
- Using Statistical Controls
- Multivariate Analysis

1. Design

You can design your research so that causal factors are made independent of each other. For example, if you think that there may be a link between age and salary, then a random sample of employees will risk combining the effects of both. If, however, you divide the population into groups by age, and then randomly sample equal numbers from each group, you have made age and salary independent.

2. Using Sub-Samples

Here, you select your sample to be equal on any potentially confounding factors. For example, job type may affect pay, so if you want to study the effects of another factor on pay, you could select only people doing the same job.

3. Using Statistical Controls

If you suspect that three variables may be linked, you can *control* for one to test for correlations between the other two. Effectively, you adjust the statistical value of the control to be constant, and test whether there is still a relationship between the other two variables. You may find that the observed relationship remains high (it is real), or reduces considerably (there is probably no real relationship). There is a third case: where there is no relationship until you control the third variable, which means that the control variable is masking the relationship between the other two.

4. Multivariate Analysis

Multivariate Analysis includes many statistical methods that are designed to allow you to include multiple variables and examine the contribution of each.

The factors that you include in your multivariate analysis will still depend on what you want to study. Some studies will want to look at the contribution of certain factors, and other studies to control for those factors as (more or less) a nuisance.

Two types of variables

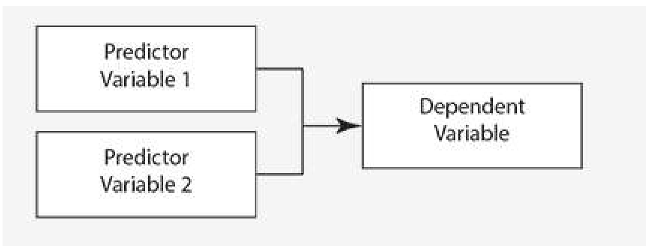
In multivariate analysis, the first thing to decide is the role of the variables.

There are two possibilities:

- The variable **causes** an effect: *predictor variable*
- The variable is **affected**: *dependent variable*

This is a function of your model, not of the variables themselves, and the same variable may be either in different studies.

The relationships between variables are usually represented by a picture with arrows:



You can also observe variables directly, or infer them from what is happening these are known as **latent variables**.

Example: Success at School

It is hard to measure '*success at school*': it is a **latent variable**.

You might decide that '*success at school*' consists of academic success, together with some measure of social success (perhaps average duration of friendships, or size of 'friendship group') plus one of effort put in. These are your observed variables.

The *measurement model* examines the relationship between the observed and latent variables.

The idea behind such models is that there are *correlations* between the observed variables.

These correlations are assumed to be caused by *common factors*. The greater the influence of the common factors (the *factor loading*), the higher the correlations between the variables.

Cronbach's alpha is used to measure the correlations between variables. A value of 0.70 or more gives a good level of reliability to the model.

METHODS OF ANALYSIS

There are a variety of methods of analysis for measurement models like this. They include **Confirmatory Factor Analysis** and **Exploratory Factor Analysis**, and are usually carried out by computer.

The details of how to carry out each one are beyond the scope of this page, but the basic idea is that they measure how much of the variation seen in the overall construct is caused by each factor.

Causal Models

Causal models look at the way in which variables relate to each other. While it is not possible to prove causality beyond doubt, causal models allow you to say whether the suggested relationship fits the data, and how well.

The strength or weakness of any causal model is the selection of the variables. If you miss out a major causal factor, then your conclusions will be either limited or incorrect. It is therefore worth taking time on defining your model as carefully as possible.

There is a balance to be struck between simplicity and including more variables to obtain a better fit. Obviously you do not want to miss out a major causal variable, and including more variables will always give a better fit. But you need to consider whether the additional complexity is worth it for the gain in quality of the model.

Suitable analysis methods for causal models tend to be what is called generalised linear models, which include *logistic regression analysis*, *multiple regression analysis*, *multivariate analysis of covariance (MANCOVA)* and*multivariate analysis of variance (MANOVA)*.

All these methods give you a measure of how much of the variation in the dependent variables is caused by the predictors, and thus whether your model is any good.

Again, there are computer packages, such as SPSS, which can do these analyses for you, but do make sure that you understand what you're doing and are interpreting the results correctly.

Structural Equation Modelling brings together measurement models and causal models. It is a computer-modelling technique that fits a structural equation to the model. This technique is pretty complicated, but in essence compares possible models and identifies the one that best fits the data.

A Complex Area

The world is a complex place, and sometimes the only way to understand what's going on is to use advanced statistical techniques for modelling.

However, these too are complex and you should not embark on them without understanding the basics. If you don't, then it's a good idea to consult someone who does, usually a statistician. Even if you've used the technique before, it's still a good idea to get a statistician to have a look at what you're planning to do and check your results afterwards in case of any glaring errors.

Poor analysis will undermine good research very quickly.

TOPIC 6
DESIGN AND FORMS OF IMPLEMENTATION OF SCIENTIFIC RESEARCH RESULTS

Plan

1. Scientific publishing.
2. Scientific monograph.
3. Legislative support for scientific research.
4. Research studies and reporting.
5. Report on a scientific topic or message and general requirements to them.
6. Structure and stages of the dissertation work.

1. **Scientific publishing**

Reviews

As review articles comprehensively cover a specific biomedical topic and justify future research directions, they require that the author extensively review and master the literature and then develop some general statements and conclusions with practical implications for patients' care[23,24]. In addition, they should provide an updated reference for those readers interested in broadening their knowledge of critical issues. Review articles are, therefore, important not only for younger physicians early in their career but also for senior academic staff as they represent a tool for intellectual enrichment and enhancement of the standards of research. Writing a review requires knowledge and continuous improvement of qualifications in line with the accumulation of better and updated scientific literature evidence. For this reason, journals often invite experts on a specific topic to write a review article. However, authors can also ask Editors if they would be interested in publishing a review article on a particular, topical, relevant and debated issue.

As reviews are the most accessed among the various types of articles and contribute substantially to the impact factor of journals, obviously they are welcomed and encouraged by many journals and have become an inseparable part of the writing scientific culture.

The three basic types of literature reviews are narrative reviews (which include editorials, commentaries and narrative overviews or non-systematic narrative reviews), qualitative systematic reviews and quantitative systematic reviews (meta-analyses) (Table).

Table

Summary of the types of literature reviews.

• - Narrative reviews: Editorials Commentaries Narrative overviews or non-systematic narrative reviews

• - Qualitative systematic reviews • - Quantitative systematic reviews (meta-analyses)

Editorials

Editorials, typically written by the editor of the journal or an invited guest, may be a narrative review if the author retrieves and summarises information about a particular topic for the reader. Usually, these types of narrative reviews are based upon a short, select and narrowly focused review of only a few papers. However, editorials may be no more than the editor's comments regarding a current issue of the journal or a current event in health care and do not, therefore, automatically qualify as narrative reviews.

Commentaries

Commentaries may also be written as a narrative review; however, they are typically written with a particular opinion being expressed. Research methodology is not usually presented in these articles which reflect the author's biased synthesis of other articles. Commentaries are usually shorter than a full-length review article and the author should be an expert in the content area of the commentary. Usually, the purpose of a commentary is to stimulate academic debate between the journal's readers.

Narrative reviews

Non-systematic narrative reviews are comprehensive narrative syntheses of previously published information. This type of literature review reports the author's findings in a condensed format that typically summarises the contents of each article. Authors of narrative overviews are often acknowledged experts in the field and have conducted research themselves. Editors sometimes solicit narrative overviews from specific authors in order to bring certain issues to light. Although the bibliographic research methodology is an obligatory section in systematic reviews and meta-analyses, it is also becoming an inseparable part of narrative literature reviews. Providing information on the databases accessed, terms, inclusion and exclusion criteria and time limits adds objectivity to the main messages and conclusions. It is advisable to use only credible databases (at least two or three) which only select high-quality publications that contain the most up-to-date information (see Table). The best way to organise the analysis of the sources in the main text of a narrative biomedical review is to transform information from the retrieved publications into bibliographic cards with a short description of the main results, level of evidence, strengths and limitations of each study and relevance to each section of the manuscript. Furthermore, the readability of a review can be improved by including a few self-explanatory tables, boxes, and figures synthesising essential information and conveying original messages. We also suggest the use of software packages for reference management, which saves time during the multiple revisions.

Table

Main online libraries, catalogues and databases.

MEDLINE/PubMed
Excerpta Medica/EMBASE

Scopus
Thomson Reuters' Web of Science
Cochrane Library
Database of Abstracts and Reviews of Effectiveness (DARE)
Cumulative Index to Nursing and Allied Health Literature (CINAHL)
Google Scholar

In conclusion, a successful narrative review should have the following characteristics: be well-structured, synthesise the available evidence pertaining to the topic, convey a clear message and draw conclusions supported by data analysis.

Qualitative systematic reviews

Qualitative systematic reviews are a type of literature review that employ detailed, rigorous and explicit methods and are, therefore, a more powerful evidence-based source to garner clinical information than narrative reviews, case reports, case series, and poorly conducted cohort studies. A detailed bibliographic research based upon a focused question or purpose is the peculiar characteristic of a systematic review[27]. These reviews are called qualitative because the process by which the individual studies are integrated includes a summary and critique of the findings derived from systematic methods, but does not statistically combine the results of all of the studies reviewed.

Quantitative systematic reviews

A quantitative systematic review or meta-analysis critically evaluates each paper and statistically combines the results of the studies. The authors of a meta-analysis employ all of the rigorous methodology of qualitative systematic reviews and, in addition, gather the original patients' data from each of the studies under review, pool it all together in a database and produce the appropriate statistics on this larger sample. While this process leads to a more powerful and generalizable conclusion, which is the strength of the meta-analysis, on the other hand it can pool together studies that are very heterogeneous which is the main drawback of a quantitative systematic review. Nevertheless, well-executed quantitative systematic reviews constitute the highest level of evidence for medical decision making.

The recently published Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement aims to help improve reporting, focusing on systematic reviews of RCT. The Statement consists of a checklist of 27 essential items for transparent reporting and a flow diagram for the phases of study selection and is accompanied by the PRISMA Explanation and Elaboration Document, which, among other things, provides examples of good reporting for the various review sections.

A further guidance on the reporting of systematic reviews has been published by the Cochrane Collaboration, an international organisation that prepares, updates and publishes systematic reviews of the effects of health-care interventions following a standardised format.

Preparing to write a manuscript Background information

The question or hypothesis formulated by the investigator is the common starting point to search the relevant published literature for an answer. Gathering the background information through an extensive literature search relevant to the topic of interest is the subsequent essential step. Peer reviewers are often experts and not citing important articles poses the manuscript at risk of rejection. It is advisable to consult at least two or three credible databases (see Table) to identify the crucial relevant articles and to track down "landmark" articles. In addition, avoid using papers published more than 10 years ago and do not rely on just the abstracts but obtain full-text articles. Articles relevant to the research topic and published in the journal in which the paper is to be submitted should be reviewed and cited.

Last but not least, the bibliographical search should also aim at finding recently published articles similar to the one the author intends to submit. In fact, a journal can be less interested in publishing such a manuscript unless the results reflect new or different findings.

Target journal

It can be worth thinking about this issue before starting to write as a proper choice of the journal can affect not only the writing style but also the ease of publication and the prompt dissemination of research. Ideally, the target journal should be the one in which similar work has been published.

Electronic and open-access journals are the latest resources for publishing and data dissemination available on the scientific journal horizon.

It is also worth considering an appropriate level of impact factor or journal quality. The impact factor of a journal is a measure reflecting the average number of citations to recent articles published in science and social science journals. It is determined by the ratio of the number of citations of papers from that journal in the whole of the biomedical literature over a 2-year period. It is frequently used as a proxy for the relative importance of a journal within its field, with journals with higher impact factors deemed to be more important than those with lower ones.

It is also extremely important to read the instructions to authors section of the selected journal carefully. In fact, although there is a general style for most biomedical journals as agreed by the ICMJE in the Uniform Requirements, individual journals may differ slightly in detail.

Authorship

It is always best to sort out authorship before writing a manuscript as authorship order can be a source of problems once the paper has been written.

Several guidelines relating to authorship are available and this issue has been extensively addressed in a recently published review article by Elizabeth Wager. Most guidelines on the authorship of scientific articles are focused more on creative and intellectual aspects of research than on routine or technical contributions.

Alhough not universally accepted, the authorship criteria suggested by the ICMJE are the ones most widely promoted by medical journals[9]. According to these criteria, co-authors should: (i) substantially contribute to conception and design of the study, acquisition of data, or analysis and interpretation of data; (ii) draft the article or revise it critically for important intellectual content; and (iii) approve the final version.

The authors are listed in decreasing order of their contribution and the senior author, or mentor, should be the last but this convention has never been codified.

It is advisable to provide accurate affiliations and contacts as they will be published on Pub Med as well as in the journal but it is also important to agree on the corresponding author who should have full access to the study data and through the provided e-mail address will be the link with the scientific community for the future[1].

Ethical issues

In addition to the authorship discussed above, there are several ethical issues involved in writing a paper. These include fabrication of data, duplicate publication, plagiarism, misuse of statistics, manipulation of images and inadequate or obviously false citations.

A must-read for all those who are involved in any editorial activity are the guidelines released by the Committee on Publication Ethics (COPE) which is a forum for editors and publishers of peer-reviewed journals to discuss all aspects of publication ethics. COPE provides advice to editors and publishers on all aspects of publication ethics and, in particular, how to handle cases of research and publication misconduct.

Writing the manuscript

Several models for the initial draft exist. A useful algorithm for writing a scientific manuscript is the one recently published by O'Connor and Holmquist. According to these authors, the writing should start with making figures and tables, and then proceed with summary statements (the conclusions summarising the major contributions of the manuscript to the scientific community), identification of the audience, materials and methods, results, discussion, references, introduction, title and conclusion. The aim of this algorithm is to give the structural backbone to the manuscript and is designed to overcome writer's block and to assist scientists who are not native English speakers.

A further and more general strategy to increase productivity during the early phases of manuscript writing is to ignore at the outset all the details that can be approached later such as structure, grammar and spelling.

The sequence of writing should address the following core sections of the paper in the order from first to last: methods, results, discussion and introduction.

"Like every well-written story, a scientific manuscript should have a beginning (Introduction), middle (Materials and Methods), and an end (Results). The Discussion (the moral of the story) puts the study in perspective. The Abstract is an opening summary of the story and the Title gives the story a name. However, as correctly pointed out by Michael McKay, "writing is not necessarily in the temporal order of the final document (i.e. the IMRAD format).

The take-home messages are, therefore: (i) a clear understanding of the essential components of each of these sections is critical to the successful composition of a scientific manuscript; (ii) the proper order of writing greatly facilitates the ease of writing; (iii) the approach to writing can be customised by authors on the basis both of the subject they are dealing with and their personal experience; (iv) the CONSORT, STROBE or PRISMA statement must be used as a guidance document for the appropriate reporting of the type of study the authors are dealing with.

In the following part of this paper the different sections of a manuscript will be dealt with in the order they are presented in the final document.

Title, keywords and abstract

The title is determinant for the indexing process of the article and greatly contributes to the visibility of the paper. It should reflect the essence of the article, its novelty and its relevance to the biomedical field it deals with. It should be clear, brief, specific, not include jargon or non-standard and unexplained abbreviations, reflect the purpose of the study and state the issue(s) addressed rather than the conclusions. Indicative titles are, therefore, better than declarative ones. Obviously, the title and abstract should correlate with each other.

Available evidence suggests that the presence of a colon in the title positively correlates with the number of citations. In other words, the more specific and accurate the description of the content is, the more chance the manuscript has of being cited.

The title of systematic reviews should ideally follow the participants, interventions, comparisons, outcomes, and study design (PICOS) approach, and include the terms “systematic review”, “meta-analysis”, or both.

The keywords enable the database searching of the article and should be provided in compliance with the instructions to authors. A careful choice from the Medical Subject Headings (MeSH) in the National Library of Medicine (NLM) controlled vocabulary thesaurus used for indexing articles in PubMed greatly increases the chances the paper is retrieved and cited by other authors.

The abstract is the last section to be written but it is the most important part of a paper because it is usually the first to be read and readers use the information contained in it to decide whether to read the whole article or not. It should be a concise summary of the manuscript and no longer than specified in the instructions to authors. Usually, abstracts do not contain references and abbreviations and acronyms are not always allowed. If required, it has to be structured in a specific way. For example, original articles submitted to Blood Transfusion, require an abstract of no more than 2,000 characters (including spaces), structured as follows: Background, Materials and methods, Results, Discussion.

A good abstract should be easy to understand and broadly appealing, informative but not too detailed. It can start with a sentence or two outlining the work; then the disease and/or system studied must be introduced and what was previously unknown has to be stated in order to provide a brief overview of the current state-of-the art knowledge on the issue. The methods must be summarised without too many details; the major findings must be clearly indicated and followed by a sentence or two showing the major implications of the paper that must be consistent with the study conclusions without overestimating their possible relevance. In the abstract the present tense should be used to refer to facts already established in the field, while the findings from the current study should be dealt with in the past tense.

Introduction

The aim of the introduction is to introduce the topic to the readers in a straightforward way, avoiding excessive wordiness. For this reason it should be short and focused, comprising approximately three paragraphs in one page.

The first paragraph should mention the questions or issues that outline the background of the study and establish, using the present tense, the context, relevance, or nature of the problem, question, or purpose (what is known).

The second paragraph may include the importance of the problem and unclear issues (what is unknown).

The last paragraph should state the rationale, hypothesis, main objective, or purpose thus clearly identifying the hypothesis to be treated and the questions addressed in the manuscript (why the study was done).

One of the most common mistakes is the failure to make a clear statement of purpose. This is because many research projects, especially retrospective clinical studies, do not start at the beginning (with the identification of a specific question, followed by methods and data collection) but begin by collecting data without first identifying a specific question to be addressed that must in any case be established before beginning to write. Data or conclusions from the study should not be presented or anticipated in the introduction section.

Writing the introduction at the end of the process prevents any block and it is easier after the methods, results and discussion have been completed.

Materials and methods

The methods section is one of the most important parts of a scientific manuscript and its aim is to give the reader all the necessary details to replicate the study.

CONSORT, STROBE and PRISMA statements provide a guideline relevant to the particular type of study.

The two essential elements of this section are a clear presentation of the study design and the identification and description of the measurement parameters used to evaluate the purpose of the study.

It is, therefore, necessary to provide a thorough explanation of the research methodology, including the study design, data collection, analysis principles and rationale. Special attention should be paid to the sample selection, including inclusion and exclusion criteria and to any relevant ethical considerations. A description of the randomisation or other group assignment methods used should be included, as should be the pre-specified primary and secondary outcome(s) and other variables.

According to the Uniform Requirements, in the case of experimental/clinical reports involving patients or volunteers, the authors must provide information about institutional, regulatory and ethical Committee authorisation, informed consent from patients and volunteers and the observance of the latest release of the Helsinki Declaration.

When reporting experiments on animals, authors should state which institutional authority granted approval for the animal experiments.

Finally, in addition to describing and identifying all the measurement parameters used, it is also important to describe any unusual statistical methodology applied, how subjects were recruited and compensated and how compliance was measured (if applicable).

Results

The results section consists of the organised presentation of the collected data. All measurements that the authors described in the materials and methods section must be reported in the results section and be presented in the same order as they were in that section. The past tense should be used as results were obtained in the past. Author(s) must ensure that they use proper words when describing the relationship between data or variables. These "data relation words" should be turned into "cause/effect logic and mechanistic words" in the discussion section. A clear example of the use of this appropriate language can be found in the article by O'Connor.

This section should include only data, including negative findings, and not background or methods or results of measurements that were not described in the methods section. The interpretation of presented data must not be included in this section.

Results for primary and secondary outcomes can be reported using tables and figures for additional clarity. The rationale for end-point selection and the reason for the non-collection of information on important non-measured variables must be explained.

Figures and tables should be simple, expand text information rather than repeat it, be consistent with reported data and summarise them. In addition, they should be comprehensible on their own, that is, with only title, footnotes, abbreviations and comments.

References in this section should be limited to methods developed in the manuscript or to similar methods reported in the literature.

Patients' anonymity is essential unless consent for publication is obtained.

Discussion

The main objective of the discussion is to explain the meaning of the results.

This section should be structured as if it were a natural flow of ideas and should start with a simple statement of the key findings and whether they are consistent with the study objectives enunciated in the last paragraph of the introduction. The strengths and the limitations of the research and what the study adds to current knowledge should then be addressed.

Through logical arguments, the authors should convert the relations of the variables stated in the results section into mechanistic interpretations of cause and effect using the present tense as these relations do exist at present. In addition, they should describe how the results are consistent or not with similar studies and discuss any confounding factors and their impact.

They should avoid excessive wordiness and other commonly made errors such as: (i) including information unrelated to the stated purpose of the article; (ii) repeating detailed data previously presented in the Results section; (iii) not interpreting and not critically analysing results of other studies reviewed and cited but rather just repeating their findings; (iv) presenting new data or new details about techniques and enrolment criteria, and (v) overstating the interpretation of the results.

Another common mistake is to forget to criticise the research described in the manuscript by highlighting the limitations of the study. The value of a scientific article is enhanced not only by showing the strengths but also the weak points of the evidence reported in the paper.

Conclusion

The conclusion is a separate, last paragraph that should present a concise and clear "take home" message avoiding repetition of concepts already expressed. The authors should also avoid excessive generalizations of the implications of the study and remember that except for RCT there can only be testable hypotheses and observed associations, rather than rigorous proof of cause and effect. Possible implications for current clinical practice or recommendations should be addressed only if appropriate.

Finally, the areas for possible improvement with future studies should be addressed avoiding ambiguous comments such as "there is a need for further research" and if there is a real need for further studies on the topic it is strongly advisable to be specific about the type of research suggested.

Acknowledgements

All contributors who do not meet the criteria for authorship should be listed in an Acknowledgements section. The authors should, therefore, add a statement on the type of assistance, if any, received from the sponsor or the sponsor's representative and include the names of any person who provided technical help, writing assistance, editorial support or any type of participation in writing the manuscript.

In addition, "when submitting a manuscript authored by a group, the corresponding author should clearly indicate the preferred citation and identify all individual authors as well as the group name. Journals generally list other members of the group in the Acknowledgments. The NLM indexes the group name and the names of individuals the group has identified as being directly responsible for the manuscript; it also lists the names of collaborators if they are listed in Acknowledgments".

References

The first suggestion is to follow the journal's policies and formatting instructions, including those for books and web-based references. Other general considerations related to references, including the following ones, can be found in the Uniform Requirements.

References to review articles are an efficient way to guide readers to a body of literature but they do not always reflect original work accurately. Papers accepted but not yet published should be designated as "in press" or "forthcoming" and information from manuscripts submitted but not accepted should be cited in the text as "unpublished observations".

Avoid using abstracts as references and citing a "personal communication" unless it provides essential information not available from a public source. In this case the name of the person and date of communication should be cited in parentheses in the text. Do not include manuscripts "in submission"

In addition it is important to remember that "authors are responsible for checking that none of the references cite retracted articles except in the context of referring to the retraction. Authors can identify retracted articles in MEDLINE by using the following search term, where pt in square brackets stands for publication type: Retracted publication [pt] in PubMed". Last but not least, remember that if a reviewer does not have access to any references he or she can ask the author for a full (pdf) copy of the relevant works.

Tips for successful revision of a manuscript

Most papers are accepted after some degree of revision. In some cases, a manuscript may be rejected after internal and editorial review only.

The process of revising a manuscript and successfully responding to the comments of reviewers and Editor can be challenging. Little has been published addressing the issue of effectively revising a manuscript according to the (minor or major) comments of reviewers. This topic was recently extensively and pragmatically covered by James M. Provenzale. The ten principles for revising a manuscript suggested by the author are reported in Table.

Table

Ten principles for revising a manuscript suggested by James M. Provenzale.

1.	Decide whether to resubmit the manuscript to the same journal
2.	Contact the editor regarding unresolved issues
3.	Prioritise the reviewers' comments
4.	Approach the reviewer as a consultant rather than an adversary
5.	Deal with reviewers' comments with which one does not agree
6.	Disagree without being disagreeable
7.	Devise a strategy for responding to divergent comments
8.	Put in the work and show all that you have done
9.	If requested, shorten the manuscript
10.	Review the medical literature before resubmission

Conclusion

Many manuscripts are not published simply because the authors have not followed the few simple rules needed to write a good article. We hope that this paper provides the reader with the basic steps to build a draft manuscript and an outline of the process needed for publishing a manuscript. However, in Table we summarise the ten principles we strongly recommend to comply with in order to improve the likelihood of publication of a scientific manuscript.

Table

Ten principles to improve the likelihood of publication of a scientific manuscript, suggested by James M. Provenzale.

1.	Organise the manuscript properly
2.	State the study question and study rationale clearly

3. Explain the materials and methods in a systematic manner
4. Structure the materials and methods and results sections in a similar manner
5. Make the discussion section concise
6. Explain if -and why- your study results are important
7. Avoid overinterpretation of the results
8. Explain the limitations of the study
9. Account for unexpected results
10. Fully incorporate reviewers’ suggestions into a revised manuscript

DIGITAL IMAGE INTEGRITY AND STANDARDS

High-resolution images are not required at initial submission. When a paper is accepted, the publishing team will request high-resolution files suitable for publication.

All digitized images submitted with the final revision of the manuscript should be 300 DPI if possible.

A certain degree of image processing is acceptable for publication (and for some experiments, fields and techniques is unavoidable), but the final image must correctly represent the original data and conform to community standards. The guidelines below will aid in accurate data presentation at the image processing level; authors must also take care to exercise prudence during data acquisition, where misrepresentation must equally be avoided. Manuscripts should include an 'equipment and settings' section with their methods that describes for each figure the pertinent instrument settings, acquisition conditions and processing changes, as described in this guide.

- Authors should list all image acquisition tools and image processing software packages used. Authors should document key image-gathering settings and processing manipulations in the methods.
- Images gathered at different times or from different locations should not be combined into a single image, unless it is stated that the resultant image is a product of time-averaged data or a time-lapse sequence. If juxtaposing images is essential, the borders should be clearly demarcated in the figure and described in the legend.
- The use of touch-up tools, such as cloning and healing tools in Photoshop, or any feature that deliberately obscures manipulations, is to be avoided.
- Processing (such as changing brightness and contrast) is appropriate only when it is applied equally across the entire image and is applied equally to controls. Contrast should not be adjusted so that data disappear. Excessive manipulations, such as processing to emphasize one region in the image at the expense of others (e.g. through the use of a biased choice of threshold settings), is inappropriate, as is emphasizing experimental data relative to the control.

When submitting revised final figures upon conditional acceptance, authors may be asked to submit original, unprocessed images.

Electrophoretic gels and blots

Positive and negative controls, as well as molecular size markers, should be included on each gel and blot – either in the main figure or an expanded data supplementary figure. For previously characterized antibodies, a citation must be provided. For antibodies less well characterized in the system under study, a detailed characterization that demonstrates not only the specificity of the antibody, but also the range of reactivity of the reagent in the assay, should be published as Supplementary Information.

The display of cropped gels and blots in the main paper is encouraged if it improves the clarity and conciseness of the presentation. In such cases, the cropping must be mentioned in the figure legend and the supplementary information should include full-length gels and blots wherever possible. These uncropped images should be labeled as in the main text and placed in a single supplementary figure. The manuscript's figure legends should state that 'full-length blots/gels are presented in Supplementary Figure X.

- Quantitative comparisons between samples on different gels/blots are discouraged; if this is unavoidable, the figure legend must state that the samples derive from the same experiment and that gels/blots were processed in parallel. Vertically sliced images that juxtapose lanes that were non-adjacent in the gel must have a clear separation or a black line delineating the boundary between the gels. Loading controls must be run on the same blot.
- Cropped gels in the paper must retain important bands.
- Cropped blots in the body of the paper should retain at least six band widths above and below the band.
- High-contrast gels and blots are discouraged, as overexposure may mask additional bands. Authors should strive for exposures with gray backgrounds. Multiple exposures should be presented in Supplementary Information if high contrast is unavoidable. Immunoblots should be surrounded by a black line to indicate the borders of the blot, if the background is faint.
- For quantitative comparisons, appropriate reagents, controls and imaging methods with linear signal ranges should be used.

Microscopy

Authors should be prepared to supply *Scientific Reports* with original data on request, at the resolution collected, from which their images were generated. Cells from multiple fields should not be juxtaposed in a single field; instead multiple supporting fields of cells should be shown as Supplementary Information.

Adjustments should be applied to the entire image. Threshold manipulation, expansion or contraction of signal ranges and the altering of high signals should be avoided. If 'pseudo-colouring' and nonlinear adjustment (e.g. 'gamma changes') are used, this must be disclosed. Adjustments of individual colour channels are sometimes necessary on 'merged' images, but this should be noted in the figure legend.

We encourage inclusion of the following with the final revised version of the manuscript for publication:

- In the methods, specify the type of equipment (microscopes/objective lenses, cameras, detectors, filter model and batch number) and acquisition software used. Although we appreciate that there is some variation between instruments, equipment settings for critical measurements should also be listed.
- An 'equipment and settings' section within the methods should list for each image: acquisition information, including time and space resolution data (xyzt and pixel dimensions); image bit depth; experimental conditions such as temperature and imaging medium; and fluorochromes (excitation and emission wavelengths or ranges, filters, dichroic beamsplitters, if any).
- The display lookup table (LUT) and the quantitative map between the LUT and the bitmap should be provided, especially when rainbow pseudocolor is used. If the LUT is linear and covers the full range of the data, that should be stated.
- Processing software should be named and manipulations indicated (such as type of deconvolution, three-dimensional reconstructions, surface and volume rendering, 'gamma changes', filtering, thresholding and projection).
- Authors should state the measured resolution at which an image was acquired and any downstream processing or averaging that enhances the resolution of the image.

BIOSECURITY CONCERNS

Policy on biosecurity

Scientific Reports' Editorial Board Members may seek advice from the Editorial Advisory Panel and the in-house publishing team about any aspect of a submitted manuscript that raises concerns. These may include, for example, ethical issues or issues of data or materials access. Very occasionally, concerns may also relate to the implications to society of publishing a paper, including threats to security. In such circumstances, advice will usually be sought simultaneously with the technical peer-review process.

The threat posed by bioweapons raises the unusual need to assess the balance of risk and benefit in publication. Editorial Board Members may not be best qualified to make such judgments unassisted, and so we reserve the right to take expert advice in cases where we believe that concerns may arise. We recognize the widespread view that openness in science helps to alert society to potential threats and to defend against them, and we anticipate that only very rarely (if at all) will the risks be perceived as outweighing the benefits of publishing a paper that has otherwise been deemed appropriate for *Scientific Reports*. Nevertheless, we think it appropriate to consider such risks and to have a formal policy for dealing with them if need arises.

Corrections and retractions

Correction and retraction policy

Scientific Reports operates the following policy for making corrections to its peer-reviewed content.

Publishable amendments must be represented by a formal online notice because they affect the publication record and/or the scientific accuracy of published information. Where these amendments concern peer-reviewed material, they fall into one of four categories: Publisher Correction (formerly Erratum), Author Correction (formerly Corrigendum), Retraction or Addendum.

Publisher Correction (formerly Erratum). Notification of an important error made by the journal that affects the publication record or the scientific integrity of the paper, or the reputation of the authors or the journal.

Author Correction (formerly Corrigendum). Notification of an important error made by the author(s) that affects the publication record or the scientific integrity of the paper, or the reputation of the authors or the journal.

Retraction. Notification of invalid results. All co-authors must sign a Retraction specifying the error and stating briefly how the conclusions are affected, and submit it for publication. In cases where co-authors disagree, the in-house editors may seek advice from independent referees and impose the type of amendment that seems most appropriate, noting the dissenting author(s) in the text of the published version.

Addendum. Notification of additional information. Addenda are published when the in-house editors decide that the addendum is crucial to the reader's understanding of a significant part of the published contribution.

Editorial decision-making

Decisions about types of correction are made by the journal's in-house editors, sometimes with the advice of referees, Editorial Advisory Panel or Editorial Board Members. This process involves consultation with the authors of the paper, but the in-house editors make the final decision about whether an amendment is required and the category in which the amendment is published.

When an amendment is published, it is linked bi-directionally to and from the article being corrected.

Authors sometimes request a correction to their published contribution that does not affect the contribution in a significant way or impair the reader's understanding of the contribution (e.g. a spelling mistake or grammatical error). *Scientific Reports* does not publish such corrections. The online article is part of the published record and hence its original published version is preserved. *Scientific Reports* does, however, correct the online version of a contribution if the wording in the html version does not make sense when compared with the PDF version (e.g. 'see left' for a figure that is an appropriate phrase for the PDF but not for the html version). In these cases, the fact that a correction has been made is stated in a footnote so that readers are aware that the originally published text has been amended.

Detailed description of correction types

Publisher Corrections (formerly Errata) concern the amendment of mistakes introduced by the journal in production, including errors of omission such as failure to make factual proof corrections requested by authors within the deadline provided by the journal and within journal policy. Publisher Corrections are generally not published for simple, obvious typographical errors, but are published when an apparently simple error is significant (e.g. a greek mu for an ‘m' in a unit, or a typographical error in the corresponding author's name).

If there is an error in the lettering on a figure, the usual procedure is to publish a sentence of rectification. A significant error in the figure itself is corrected by publication of a new corrected figure as a Publisher Correction. The figure is republished only if the Editorial Board Member considers it necessary for a reader to understand it.

Author Corrections (formerly Corrigenda) are judged on their relevance to readers and their importance for the published record. Author Corrections are published after discussion among the Editorial Board Members, Editorial Advisory Panel and the publishing team. All co-authors must sign an agreed wording.

Author Corrections submitted by the original authors are published if the scientific accuracy or reproducibility of the original paper is compromised; occasionally, on investigation, these may be published as Retractions. In cases where some co-authors decline to sign an Author Correction or Retraction, we reserve the right to publish it with the dissenting author(s) identified. *Scientific Reports* publishes Author Corrections if there is an error in the published author list, but not for overlooked acknowledgements.

Retractions are judged according to whether the main conclusion of the paper no longer holds or is seriously undermined as a result of subsequent information coming to light of which the authors were not aware at the time of publication. In the case of experimental papers, this can include further experiments by the authors or by others that do not confirm the main experimental conclusion of the original publication. Readers wishing to draw the Editorial Board Members' attention to published work requiring retraction should first contact the authors of the original paper and then write to the publishing team, including copies of the correspondence with the authors (whether or not the correspondence has been answered). The publishing team and Editorial Board Member will seek advice from referees if they judge that the information is likely to draw into question the main conclusions of the published paper.

Addendum. Notification of additional information about a paper, usually in response to readers' request for clarification. Addenda, including Editorial Expressions of Concern, are published when the in-house editors decide that the addendum is crucial to the reader's understanding of a significant part of the published contribution.

Supplementary information

Author Corrections to Supplementary Information (SI) are made only in exceptional circumstances (e.g. major errors that compromise the conclusion of the study). Published corrections to SI are usually linked to the Author Correction statement. Authors cannot update SI because new data have become available or interpretations have changed, as the SI is a peer-reviewed and integral part of the paper, and hence part of the published record.

SI cannot be amended between acceptance and publication unless a change made for technical reasons by the journal in order to publish the material on the website has introduced a significant error.

Duplicate publication

Material submitted to *Scientific Reports* must be original and not published or submitted for publication elsewhere. This rule applies to material submitted elsewhere while the *Scientific Reports* contribution is under consideration.

Authors submitting a contribution to *Scientific Reports* who have related material under consideration or in press elsewhere should upload a clearly marked copy at the time of submission, and draw the Editorial Board Members' attention to it in their cover letter. Authors must disclose any such information while their contributions are under consideration by *Scientific Reports* – for example, if they submit a related manuscript elsewhere that was not written at the time of the original *Scientific Reports* submission.

If part of a contribution that an author wishes to submit to *Scientific Reports* has appeared or will appear elsewhere, the author must specify the details in the covering letter accompanying the submission. Consideration by *Scientific Reports* is possible if the main result, conclusion, or implications are not apparent from the other work, or if there are other factors, for example if the other work is published in a language other than English.

Scientific Reports is happy to consider submissions containing material that has previously formed part of a PhD or other academic thesis which has been published according to the requirements of the institution awarding the qualification.

Scientific Reports allows and encourages prior publication on recognized community preprint servers for review by other scientists in the field before formal submission to a journal. The details of the preprint server concerned and any accession numbers should be included in the cover letter accompanying submission of the manuscript to *Scientific Reports*. This policy does not extend to preprints available to the media or that are otherwise publicized outside the scientific community before or during the submission and consideration process at *Scientific Reports*.

Scientific Reports allows publication of meeting abstracts before the full contribution is submitted. Such abstracts should be included with the submission and referred to in the cover letter accompanying the manuscript. This policy does not extend to meeting abstracts and reports available to the media or which are otherwise publicized outside the scientific community during the submission and consideration process.

Scientific Reports is happy to consider submissions containing material that has previously formed, and continues to form, part of an online scientific collaboration such as a wiki or blog, provided that the information has not been publicized outside the scientific community, and is not publicized until the publication date of the work in *Scientific Reports*. In case of any doubt, authors should seek advice from the Editorial Board Member handling their contribution.

If an author of a submission is re-using a figure or figures published elsewhere, or that is copyrighted, the author must provide documentation that the previous publisher or copyright holder has given permission for the figure to be re-published. *Scientific Reports*Editorial Board Members consider all material in good faith that the publication has full permission to publish every part of the submitted material, including illustrations.

Confidentiality and pre-publicity

Confidentiality

Scientific Reports keeps all details about a submitted manuscript confidential and does not comment to any outside organization about manuscripts that are either under consideration or that have been rejected.

After a manuscript is submitted, correspondence with *Scientific Reports*, referees' reports and other confidential material, regardless of whether or not the submission is eventually published, must not be posted on any website or otherwise publicized without prior permission. The Editorial Board Members themselves are not allowed to discuss manuscripts with third parties or to reveal information about correspondence and other interactions with authors and referees.

Referees of manuscripts submitted to *Scientific Reports* undertake in advance to maintain confidentiality of manuscripts and any associated supplementary data.

Pre-publicity

Our policy on the posting of particular versions of the manuscript is as follows:

1. You are welcome to post pre-submission versions or the original submitted version of the manuscript on a personal blog, a collaborative wiki or a recognised preprint server at any time. The website and URL must be identified in the cover letter accompanying submission of the paper to *Scientific Reports*.

2. Material in a paper submitted to *Scientific Reports* may also have been published as part of a PhD or other academic thesis.

3. *Scientific Reports* articles are open access and can replace the original submitted version immediately, on publication, as long as a publication reference and URL to the published version on the *Scientific Reports* website are provided.

Scientific Reports supports open communication between researchers, whether on a recognised preprint server, through discussions at research meetings, or via online collaborative sites such as wikis. Neither conference presentations nor posting on recognised preprint servers constitute prior publication.

Researchers are welcome to respond to requests from the media in response to a preprint or conference presentation, by providing explanation or clarification of the work, or information about its context. In these circumstances, media coverage will not hinder editorial handling of the submission.

Researchers should be aware that such coverage may reduce or pre-empt coverage by other media at the time of publication. We also advise that researchers approached by reporters in response to a preprint make it clear that the paper has not yet undergone peer review, and that the content is provisional. Details of peer review should be kept confidential.

We believe it important that the final published version of a paper be publicly available when the work is discussed in the media. For that reason, we strongly discourage the direct solicitation of media coverage to appear ahead of publication of the final version of a paper.

Authors of papers that contain taxonomy (i.e. the formal nomenclature and description of a newly discovered species) should be aware that it is possible for third parties to exploit the prior publication of nomenclature at any time between online posting of a preprint and the publication date in a journal, by publishing the name in print and asserting priority according to the rules of the Code of Zoological Nomenclature. *Scientific Reports* takes no responsibility for such assertions of priority in the case of manuscripts it publishes if the content of those manuscripts has previously appeared in the public domain as online preprints or other form of online posting.

Plagiarism

Plagiarism is unacknowledged copying or an attempt to misattribute original authorship, whether of ideas or text. As defined by the ORI (Office of Research Integrity), plagiarism can include, “theft or misappropriation of intellectual property and the substantial unattributed textual copying of another's work”. Plagiarism can be said to have clearly occurred when large chunks of text have been cut-and-pasted without appropriate and unambiguous attribution. Such manuscripts would not be considered for publication in *Scientific Reports*. Aside from wholesale verbatim re-use of text, due care must be taken to ensure appropriate attribution and citation when paraphrasing and summarising the work of others. 'Text recycling' or re-use of parts of text from an author’s previous research publication is a form of self-plagiarism. Here, too, due caution must be exercised. When re-using text, whether from the author's own publication or that of others, appropriate attribution and citation is necessary to avoid creating a misleading perception of unique contribution for the reader.

Duplicate publication occurs when an author re-uses substantial parts of his or her own published work without providing the appropriate references. This can range from getting an identical paper published in multiple journals, to 'salami-slicing', where authors add small amounts of new data to a previous paper.

Scientific Reports' Editors and Editorial Board members assess all such cases on their individual merits. When plagiarism becomes evident post-publication, we may correct or retract the original publication depending on the degree of plagiarism, context within the published article and its impact on the overall integrity of the published study.

Scientific Reports is part of Similarity Check, a service that uses software tools to screen submitted manuscripts for text overlap.

Due credit for others' work

Discussion of unpublished work: Manuscripts are sent out for review on the condition that any unpublished data cited within are properly credited and the appropriate permission has been sought. Where licensed data are cited, authors must include at submission a written assurance that they are complying with originators' data-licensing agreements.

Referees are encouraged to be alert to the use of appropriated unpublished data from databases or from any other source, and to inform *Scientific Reports* of any concern they may have.

Discussion of published work: When discussing the published work of others, authors must properly describe the contribution of the earlier work. Both intellectual contributions and technical developments must be acknowledged as such and appropriately cited.

2. Scientific monograph

Scientific monograph. What exactly is it and just how do you really write it?

Scientific monograph is a study work which contains a full or in-depth research of 1 issue or topic owned by several authors. The monograph captures the medical priority, gives the main medical information culture, acts to emphasize the key content and link between systematic, dissertation research.

There are particular standard popular features of a systematic monograph. They truly are:

- amount – no less than 10 publishing documents;
- presence of reviews of two physicians of sciences into the matching specialty;
- availability of the suggestion of this educational council of the research organization or maybe more educational organization;
- circulation of no less than 300 copies;
- accessibility to worldwide standard,
- full the value of life essay compliance utilizing the editorial requirements for a monograph prior to hawaii requirements;
- accessibility to a monograph when you look at the funds of libraries.

Usually, the compositional framework of a scientific monograph is rolling out: name page, abstract, range of symbols (if necessary), introduction or preface, main component, conclusions or afterword, literature, auxiliary indexes, appendices, articles. The monograph is supposed primarily for scientists and may lead to this content and kind of the publication genre. Of particular importance here you will find the quality for the wording and presentation associated with material, the logic of coverage associated with main some ideas, ideas, conclusions. Its amount ought to be at the least 10 im printed sheets. Needs into the essence of this presentation for the product within the parts of the monograph are similar to what’s needed of other systematic magazines with certain options that come with their purpose.

Distinction between fundamental and used research

In scientific work, various studies are carried out, but each of their variety could be paid off to two main types.

Fundamental research is a vital separate part of systematic work and plays a substantial role into the growth of technology it self and its particular further use within the manufacturing process. The consequence of these studies may be the development of the latest guidelines of nature, society and reasoning, systematization, expansion and deepening of real information on a certain systematic problem.

Applied scientific studies are another direction of systematic work. It offers research and development work, that are conducted using the goal of developing the essential principles of manufacturing brand new technology and advanced level technology. It really is through such research that science is directly taking part in production, changing systematic a few ideas into material processes and objects.

In the act of systematic work, experts keep in touch with one another, utilizing a unique form of speech, called “scientific style”. Such a mode is described as a desire to have an obvious phrase of idea, strict logic of presentation, accuracy and unambiguousness for the wording.

The language of technology uses primarily book and neutral language, in addition to special terminology. It is the existence in the message of researchers of a lot of special terms first differentiates it from ordinary talked language.

Monograph Title
Sub Title

First Author
Second Author
Third Author
Forth Author

PREFACE is an introduction to a Monograph or other literary work written by the work's author. A preface is a section or page of the front and back matter of a book that includes explanatory remarks about the book.

The preface often closes with acknowledgements of those who assisted in the literary work.

Author details come here.

Table of Content

INTRODUCTION

This article guides a stepwise walkthrough by Experts for writing a successful journal or a research paper starting from inception of ideas till their publications. Research papers are highly recognized in scholar fraternity and form a core part of PhD curriculum. Research scholars publish their research work in leading journals to complete their grades. In addition, the published research work also provides a big weight-age to get admissions in reputed varsity. Now, here we enlist the proven steps to publish the research paper in a journal.

A. What is Monograph?

In this approach combine all your researched information in form of a journal or research paper. In this researcher can take the reference of already accomplished work as a starting building block of its paper.

Jump Start

This approach works the best in guidance of fellow researchers. In this the authors continuously receives or asks inputs from their fellows. It enriches the information pool of your paper with expert comments or up gradations. And the researcher feels confident about their work and takes a jump to start the paper writing.

B. How to write a Monograph?

There are numbers of software available which can mimic the process involved in your research work and can produce the possible result. One of such type of software is Matlab. You can readily find Mfiles related to your research work on internet or in some cases these can require few modifications. Once these Mfiles are uploaded in software, you can get the simulated results of your paper and it easies the process of paper writing.

As by adopting the above practices all major constructs of a research paper can be written and together compiled to form a complete research ready for Peer review.

1. IDENTIFY, RESEARCH AND COLLECT IDEA

It's the foremost preliminary step for proceeding with any research work writing. While doing this go through a complete thought process of your Journal subject and research for it's viability by following means:

1) Read already published work in the same field.
2) Goggling on the topic of your research work.
3) Attend conferences, workshops and symposiums on the same fields or on related counterparts.
4) Understand the scientific terms and jargon related to your research work.

2. WRITE DOWN YOUR STUDIES AND FINDINGS

Now it is the time to articulate the research work with ideas gathered in above steps by adopting any of below suitable approaches:

A. Bits and Pieces together

In this approach combine all your researched information in form of a journal or research paper. In this researcher can take the reference of already accomplished work as a starting building block of its paper.

Jump Start

This approach works the best in guidance of fellow researchers. In this the authors continuously receives or asks inputs from their fellows. It enriches the information pool of your paper with expert comments or up gradations. And the researcher feels confident about their work and takes a jump to start the paper writing.

B. Use of Simulation software

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Mfiles are uploaded in software, you can get the simulated results of your paper and it easies the process of paper writing.

As by adopting the above practices all major constructs of a research paper can be written and together compiled to form a complete research ready for Peer review.

3. IMPROVEMENT AS PER REVIEWER COMMENTS

Analyze and understand all the provided review comments thoroughly. Now make the required amendments in your paper. If you are not confident about any review comment, then don't forget to get clarity about that comment. And in some cases there could be chances where your paper receives number of critical remarks. In that cases don't get disheartened and try to improvise the maximum.

After submission IJSRP will send you reviewer comment within 10-15 days of submission and you can send us the updated paper within a week for publishing.

This completes the entire process required for widespread of research work on open front. Generally all International Journals are governed by an Intellectual body and they select the most suitable paper for publishing after a thorough analysis of submitted paper. Selected paper get published (online and printed) in their periodicals and get indexed by number of sources.

4. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

A

- Example entry in the Glossary.

B

- Some content related to B
- Some more glossary

S

- If there are no glossary for continuous, skip alphabets

3. Legislative support for scientific research

LAW OF UKRAINE

On Scientific and Scientific and Technology Activities

As amended and supplemented by the Resolutions of the Cabinet of Ministers of Ukraine No. 12-92 dated December 26, 1992 No. 23-92 dated December 31, 1992 No. 15-93 dated February 19, 1993 Laws of Ukraine No.183/94-VR dated September 23, 1994 No. 75/95-VR dated February 28, 1995 No. 498/95-VR dated December 22, 1995 No. 608/96-VR dated December 17, 1996 No. 284-XIV dated December 1, 1998 (Law of Ukraine No. 284-XIV dated December 1, 1998 this Law was stated in a new version), No. 1646-III dated April 6, 2000 No. 2905-III dated December 20, 2001 No. 3065-III dated February 7, 2002 No. 380-IV dated December 26, 2002 No. 581-IV dated February 20, 2003 No. 860-IV dated May 22, 2003 No. 1096-IV dated July 10, 2003 No. 1316-IV dated November 20, 2003 No.1344-IV dated November 27, 2003 No. 1377-IV dated December 11, 2003 No. 1407-IV dated February 3, 2004 No. 2094-IV dated October 19, 2004 No. 2261-IV dated December 16, 2004 No. 3108-IV dated November 17, 2005 No. 3421-IV dated February 9, 2006 No. 190-V dated September 22, 2006 No. 489-V December 19, 2006(Amendments introduced by the Law of Ukraine No. 1646-III dated April 6, 2000 regarding scientific (science/pedagogical) personnel, who do not hold a scientific degree or academic title shall come into effect after the Law of Ukraine “On State Budget of Ukraine” for the year 2002) comes into force.

(It was determined that from January 1, 2007 the maximum amount of pension or monthly lifetime cash allowance (with taking into consideration of increments, augmentations, additional pensions, targeted cash assistance, pensions for special merits before Ukraine and other pension supplements, set out by the legislation), allocated (transferred) in the years 2006 -2007 in accordance with the present Law cannot exceed 12 minimum retirement pensions, establishedby indent one, paragraph one of Article 28 of the Law of Ukraine “On Obligatory State Pension Insurance”, according to the Law of Ukraine No. 489-V dated December 19, 2006) (It was determined that in the year 2007 for working pensioners, subject to the presentLaw, the retirement pension assigned in advance (with taking into consideration of subparagraph "г" point 1 of Article 26 of the Law of Ukraine “On Employment of Population”, subparagraph "в" in paragraph two of Article 12 of The Law of Ukraine “On general principles of further Chernobyl NPP operation and decommissioning and destroyed fourth Unit of this NPP transformation into ecologically safe system ” and Article 21 of the Law of Ukraine “On General Principles of Social Protection of Labor Veterans and other Citizens of Advanced Age in Ukraine”) for the period before reaching of retirement age, envisaged by the legislation for corresponding category of people, shall not be paid according to the Law of Ukraine No. 489-V dated December 19, 2006) (It was determined that in the year 2007 retirement pension according to the present Law shall be paid only in the case of reaching of retirement age, envisaged by Article 26 of the Law of

Ukraine “On Obligatory State Pension Insurance” according to the Law of Ukraine No. 489-V dated December 19, 2006)

(In the text of the Law the words “Ministry of Economy of Ukraine” in all cases shall be replaced by the words “central executive authority in the field of economic policy” in appropriate case according to the Law of Ukraine No. 860-IV dated May22, 2003)

(In the text of the Law the words “Ministry of Ukraine for Science and Technology” in all cases shall be replaced by the words “central executive authority in the field of scientific, scientific and technology and innovation activity” in appropriate case according to the Law of Ukraine No. 2261-IV dated December 16, 2004)

This Law sets out legal, organizational, and financial principles of the operation and the development of the science and technology, creates conditions for the scientific and scientific and technology activities, and the satisfaction of technology development needs of the society and the state.

The science and technology development is a determining factor of the advancement of the society, the enhancement of its well-being, the spiritual and intellectual development of its members. This makes it necessary to provide the state support on a priority basis to the development of the science as a source of the economic growth and an integral component of the national culture and education, the creation of conditions for the realization of the intellectual potential of individuals in the field of scientific and scientific and technology activities, the targeted policy in the field of securing the utilization of achievements of the domestic and international science and technology for the satisfaction of social, economic, cultural and other needs.

Section I. GENERAL PROVISIONS

Article 1. Main Terms and Definitions

The terms used herein shall have the following meanings:

scientific activities - the intellectual creative activities focused on the obtainment and the utilization of the new knowledge. The fundamental research and applied scientific research are major forms thereof;

scientific and technology activities - the intellectual creative activities focused on the obtainment and the utilization of the new knowledge in all areas of engineering and technology. Its major forms (types) shall be the scientific research, research and engineering, design and engineering, process, survey and design/survey work, manufacture of test samples or batches of scientific and technology products, as well as the other work associated with bringing the scientific and scientific and technology knowledge to the stage of the practical utilization thereof;

scientific and pedagogical activity – the pedagogical activities carried out at higher educational institutions and postgraduate institutions of 3rd and 4th accreditation levels, related to scientific and/or scientific and technology activities;

science/organizational activities – the activities focused on methodical and organizational support, as well as at coordination of scientific, scientific and technology and scientific and pedagogical activity;

(Article 1 amended by adding indents four and five according to the Law of Ukraine No. 1646-III dated April 06, thereby indents four-eleven shall be considered

correspondingly as indents six-thirteen)

fundamental scientific researches – the scientific theoretical and/or experimental activities focused on obtainment of the new knowledge regarding principles of development of nature, society, human being and their interrelation;

applied scientific researches – the scientific and scientific and technology activities focused on obtainment and utilization of the knowledge for practical purposes;

scientist – an individual (the citizen of Ukraine, foreign citizen or an individual without citizenship), who holds complete higher education and carries out fundamental and/or applied scientific researches and obtains scientific and/or scientific and technology results;

(indent eight of Article 1 amended by the

Laws of Ukraine No.1646-III dated April 06,2000 No. 1316-IV dated November 20, 2003)

young scientist – a scientist under 35 years old;

(Article 1 amended by adding new indent nine according to the Law of Ukraine No. 581-IV dated February 20, 2003 thereby indents nine-fourteen shall be considered correspondingly as indents ten-fifteen)

research scientist – a scientist, who by his/her primary work location and according to the labor agreement (contract) professionally practices scientific, scientific and technology or scientific and pedagogical activities and holds appropriate qualification, approved by the results of attestation, regardless of existence of scientific degree or academic title;

(indent ten of Article 1 as amended by

the Law of Ukraine No. 1646-III dated April 06)

scientific and pedagogical worker - a scientist, who by his/her primary work location professionally practices pedagogic and scientific and technology activities at higher and postgraduate educational institutions of 3rd - 4th accreditation levels;

(Article 1 amended by adding of new indent eleven according to the Law of Ukraine No. 1646-III dated April 06, 2000 thereby indents ten-thirteen shall be correspondingly considered as indents eleven-fourteen)

science/research (science/technology) institution – a legal entity regardless of type of ownership, established according to the procedure set out by the current legislation, for which scientific and scientific and technology activities is the principal activity and makes over 70 percent of general annual amount of accomplished work;

scientific work – the research with the purpose of scientific result obtainment;

scientific result – the new knowledge obtained in the process of fundamental or applied scientific researches and documented on the scientific information media in the form of report, scientific work, scientific paper, scientific statement on scientific and research activities, monographic research, scientific discovery etc.;

scientific applied result – the new structural or technological concept, experimental model, accomplished test and/or development, which is or could be introduced into social practice. Scientific applied result could be presented in the form of report, draft project, construction or production documentation regarding scientific and technology product, full-scale specimens etc.

Article 2. Purpose and tasks

The purpose of this Law is regulation of relations, coming from scientific and scientific and technology activities and providing conditions necessary for efficiency improvement of scientific researches and utilization of the results thereof for development of all areas of social life.

The main tasks of the Law are definition of:

legal status of subjects of the scientific and scientific and technology activities, material and moral stimuli ensuring prestige and priority of this sphere of people's activity, attraction to it of intellectual potential of nation;

economic, social and legal guarantees of scientific and scientific and technology activities and freedom of scientific work;

primary targets, directions and principles of the state policy in the area of scientific and scientific and technology activities;

powers of governmental authorities concerning implementation of government regulation and administration in the field of scientific and scientific and technology activities.

Article 3. Legislation of Ukraine on Scientific and Scientific and technology Activities

Legislation of Ukraine on scientific and scientific and technology activities consists of the present Law and other regulatory legal acts, which cover relations, arising in the process of the above mentioned activity.

Section II. LEGAL STATUS OF THE SUBJECTS OF SCIENTIFIC AND SCIENTIFIC AND TECHNOLOGY ACTIVITIES

Article 4. Subjects of Scientific and Scientific and technology Activities

The following shall be the subjects of scientific and scientific and technology activities: scientists, research workers, scientific and pedagogical workers, scientific institutions, scientific organizations, higher educational institutions of 3rd - 4th accreditation levels and public organizations working in the area of scientific and scientific and technology activities (named hereinafter to as public scientific organizations).

Article 5. Scientist

Scientist is a principal subject of scientific and scientific and technology activities

Scientist shall have right to:

choose the directions and methods of scientific and scientific research activity in accordance with his/ her interests, creative abilities and the principles of humanism;

cooperate with other scientists within permanent or temporary scientific groups for joint scientific and scientific and technology activities;

participate in scientific research competitions, financed out of the funds of the State Budget of Ukraine and other sources according to the current legislation of Ukraine;

receive recognition of authorship regarding scientific and scientific and technology results of his/her activity;

publish results of his/her researches or disclose them in the other way according to the procedure set out by the current legislation of Ukraine;

participate in the competitions to fill the vacancy of scientific and science/pedagogic workers;

receive, transmit and distribute scientific information;

receive state and public recognition in relation with awarding of scientific degrees, academic titles, premiums, honorary titles for scientific and technological contributions, manufacturing application of scientific and scientific and technology results and for training for scientific personnel.

Scientist during carrying out of scientific and scientific and technology activities shall be obliged to:

bring no harm to human health, life and environment;

adhere to ethical norms of scientific community and to respect the right of intellectual property.

Article 6. Research Worker

Research scientist can carry out science/research, science/pedagogical, research/engineering, research/technological, project/designing, project/technological, investigation and project/investigation work and/or organize carrying out of the above mentioned works at scientific institutions, higher educational institutions of 3rd - 4th accreditation levels and/or laboratories of the enterprises.

Research scientist shall have right to:

be a part of trade unions and participate in activity of public organizations and political parties;

give a motivated refusal to participate in scientific (science/technology) activity, which can result to negative consequences for human being, society or environment;

receive material support for investigations out of the State Budget of Ukraine and other financial sources according to the current legislation of Ukraine;

receive personal and other scholarships and premiums, set out by the state, legal entities and individuals;

objective estimation of his/her activity and obtaining of remuneration according to qualification, scientific results, quality and complexity of the accomplished work, and to gain income or other remuneration from implementation of scientific or scientific applied result of his/her activity;

carry out training activity, render consultative assistance and act as an expert according to the current legislation of Ukraine;

carry out business activity according to the current legislation of Ukraine.

Research scientist shall be obliged to:

carry out scientific researches according to the signed agreements (contracts);

represent the results of scientific and scientific and technology activities by means of scientific reports, publications and theses' defense;

pass attestation for adequacy for the job according to the established procedure;

constantly upgrade his/her skills.

Employment of research workers shall take place according to the result of competitive selection.

Research scientist cannot be forced to carry out scientific researches, if they or results thereof bring or could bring to negative consequences for human health, life and/or for environment, he/she cannot be hold accountable for denial to participate in the above mentioned researches.

Article 7. Scientific Institution

Scientific institution acts on the basis of the statute (regulation), approved according to the established procedure.

Manager of scientific institution shall exercise control of its activity.

Manager of a scientific institution, as a rule, shall be elected by secret voting at the meeting of research scientists for the term determined by the statute (regulation) of a scientific institution and shall be approved by the owner of scientific institution or its authorized body, if otherwise is not set out by the statute (regulation) of scientific institution.

Managers of structural subdivisions of scientific institution shall be elected for the posts according to the result of competitive selection, pursuant to the procedure, set out by the statute (regulation) of the above mentioned institutions.

Article 8. State Scientific Institutions

State scientific institutions shall be scientific institutions, established on the basis of state ownership.

State scientific institutions shall be established, reorganized and liquidated according to the procedure set out by the Cabinet of Ministers of Ukraine, if otherwise is not set out by the legislation.

Land plots shall be transmitted on a permanent basis to the state scientific institutions according to the current legislation of Ukraine.

Article 9. Rights and obligations of Manager of a Scientific Institution

Manager of scientific institution shall:

decide the issues related to its activity according to the statutory goals;

represent scientific institution before the bodies of state power and local self-government authorities, enterprises, establishments and organizations of all ownership types;

be responsible for the results of scientific institution's activity before the owner or his/her authorized body;

issue orders and decrees within his/her competence;

determine employees' spheres of action;

appoint a part of composition of academic (scientific, science/technology) council of scientific institution;

exercise other powers, envisaged by the statute (regulation) of scientific institution.

Manager of scientific institution annually shall render an account to the group of research workers regarding his/her activity.

Article 10. Academic (scientific, science/technology) Council of Scientific Institution

Academic (scientific, science/technology) council of scientific institution is a collegial advisory body, managing scientific and scientific and technology activities of scientific institution.

Quantitative composition of academic (scientific, science/technology) council of scientific institution shall be determined by the statute (regulation) of scientific institution. At least three fourth of the composition of academic (scientific, science/technology) council of scientific institution shall be elected by secret voting of the group of research workers, and the rest of membership shall be appointed by the manager of the mentioned scientific institution.

Manager of scientific institution, his/her assistants and academic secretary of scientific institution shall be the members of academic (scientific, science/technology) council of scientific institution according to their posts.

In order to represent the interests of employees, a head of primary trade union organization (trade union representative) can be a member of academic (scientific, science/technology) council of scientific institution (upon agreement).

(paragraph four of Article 10 amended according
to the Laws of Ukraine No. 1096-IV dated July 10, 2003)

Academic (scientific, science/technology) council of scientific institution shall:

determine prospective lines of scientific and scientific and technology activity;

carry out scientific and scientific and technology assessment of the lines and results of scientific and research works;

consider and approve current plans of scientific researches;

approve the topics of candidates' and post graduate students' theses and their research advisors (consultants);

approve the results of research workers' attestation;

elect on a competitive basis research workers to fill the vacancy;

consider issues within its competence regarding awarding of scientific degrees;

solve other issues of scientific institution's activity, determined by its statute (regulation).

Special academic councils could be established at scientific institution for defense of theses by corresponding specialties according to the procedure, envisaged by the current legislation of Ukraine.

Article 11. State Attestation of Scientific Institutions

In order to assess the efficiency of activity of scientific institutions, conformity of results obtained by them to the state scientific and technology priorities and tasks of scientific and technology development and in order to determine the necessity of their provision with the state support, state attestation of scientific institutions shall be carried out according to the procedure, established by the Cabinet of Ministers of Ukraine.

Scientific institutions of all types of ownership, which are entered or claim to be entered to the State Register of Scientific Institutions, supported by the state, shall be subject to state attestation.

Article 12. State Register of Scientific Institutions, Supported by the State

In order to provide state support for scientific institutions of all types of ownership, which carry out activity of significant importance for science, economy and industry, the State Register of Scientific Institutions, supported by the state shall be established. Regulation on the State Register of Scientific Institutions shall be approved by the Cabinet of Ministers of Ukraine.

Scientific institutions shall be included to the State Register of Scientific Institutions by the central executive authority in the field of scientific, scientific and technology and innovational activity, provided that they have passed the state attestation.

Scientific institutions, included to the State Register of Scientific Institutions shall:

have tax remissions according to the current legislation of Ukraine;

not be able to change scientific and scientific and technology activity to other types of activity;

be obliged to direct at least 50 of their income for carrying out of independent scientific-researches and for development of research material and technical basis.

Scientific institutions, included to the State Register of Scientific Institutions shall be stroke off the register in the case of their nonconformity to the requirements, envisaged by the present Law.

Article 13. National Scientific Center

Status of the national scientific center could be awarded to scientific institutions and/or higher educational institutions of 4th accreditation level (group of scientific institutions or higher educational institutions of 4th accreditation level), which carry out integrated researches of nationwide significance and their activity is recognized worldwide.

Awarding and withdrawal of the status of national scientific center shall be carried out by the Edict of the President of Ukraine upon recommendation of the Cabinet of Ministers of Ukraine.

Status and peculiarities of national scientific centers’ activity shall be determined by the Regulation on national scientific center, which shall be approved by the Cabinet of Ministers of Ukraine.

Article 14. State Register of Scientific Facilities being the National Endowment

In order to preserve unique scientific facilities: collections, information files, research installations and equipment, landscape protection areas, arboretums, scientific training areas etc., which have particular significance for Ukrainian and world science, the State Register of Scientific Facilities, being the national endowment shall be established.

Procedure of forming and maintenance of the State Register of Scientific Facilities, being the national endowment shall be determined by the Cabinet of Ministers of Ukraine.

Decision on consideration of facilities as such, that represent the national endowment shall be adopted by the Cabinet of Ministers of Ukraine upon recommendation of the central executive authority in the field of scientific, scientific and technology and innovation activity.

Financing of the measures on maintenance and preservation of scientific facilities, included to the State Register of Scientific Facilities being the national endowment, shall be envisaged at the State Budget of Ukraine on annual basis.

Article15. National Academy of Science of Ukraine and Branch Academies of Science

National Academy of Science and branch academies of science – Ukrainian Academy of Agrarian Sciences, Academy of Medical Sciences of Ukraine, Academy of Pedagogical Sciences of Ukraine, Academy of Legal Sciences of Ukraine, Academy of Arts of Ukraine (named hereinafter to as academies) shall be state scientific organizations, established on national property.

Funds for ensuring activity of academies shall be annually determined at the State Budget of Ukraine by separate lines. Academies could be financed out of other sources, permitted by the current legislation of Ukraine.

Scientific institutions, enterprises, organizations, social facilities, which ensure academies' activity, could be the part thereof.

National administration in the field of scientific and scientific and technology activity of academies shall be exercised according to the current legislation of Ukraine within the limits, which do not infringe their autonomy and freedom of scientific work in the course of their statutory activity.

Autonomy of academies lies in independent determination of the subject-matter of researches, their structure, solving of scientific/managerial, economic and personnel issues, effecting of international scientific relations.

Academies perform orders of the governmental authorities regarding elaboration of the principles of the state scientific and scientific and technology policy and carrying out scientific expertise of draft state decisions and programs.

Academies annually report to the Cabinet of Ministers of Ukraine about results of scientific and scientific and technology activity and utilization of funds, allocated out of the State Budget of Ukraine.

National Academy of Science of Ukraine – higher scientific institution of Ukraine, which shall organize and carry out fundamental and applied research on the most important problems of natural, technical and humane sciences and coordinate fundamental research at the scientific institutions and organizations regardless of their type of ownership. Interdepartmental council on coordination of fundamental research in Ukraine shall be established at the National Academy of Science of Ukraine (named herein after to as council). Regulation on the council and membership thereof shall be approved by the Cabinet of Ministers of Ukraine.

Branch academies shall coordinate, organize and carry out researches in the appropriate branches of science and technology.

State shall transmit to academies permanent and operating assets into permanent free-of-charge use without change of ownership right. Assets, transmitted to academies shall be utilized according to the current legislation and statutes of academies. Land plots shall be transmitted to academies into permanent use or leased according to the land laws of Ukraine.

(paragraph ten of Article 15 amended by
the Law of Ukraine No. 1377-IV dated December 11, 2003)

National Academy of Science of Ukraine shall carry out its activity according to the current legislation of Ukraine, its statute, which shall be approved by the general meeting of the National Academy of Science and registered by the Ministry of Justice of Ukraine.

Branch academies of science of Ukraine shall carry out their activity according to the current legislation of Ukraine and their statutes, which shall be adopted by the general meeting of academies. Statutes of the branch academies of science shall be approved by the Cabinet of Ministers of Ukraine.

(paragraph eleven of Article 15 was replaced by paragraph eleven and twelve
according to the Law of Ukraine No. 3065-III dated February 07,.2002 thereby paragraph twelve shall be considered as paragraph thirteen)

General meeting of the National Academy of Science and branch academies of science shall have exclusive right to elect the Ukrainian scientists to be full members (academicians) and associate members, and the foreign scientists – to be foreign members of corresponding academies.

Articles 16. Scientific and Scientific and technology Activity in the System of Higher Education

Scientific and scientific and technology activity is an integral part of training process of higher educational institutions of 3rd - 4th accreditation levels.

Scientific and scientific and technology activity in the system of higher education shall be carried out according to the Laws of Ukraine “On education”, “On Higher Education” and the present Law.

(paragraph two of Article 16 amended
according to the Law of Ukraine No. 1316-IV dated November 20,.2003)

Higher educational institutions of 3rd - 4th accreditation levels shall be covered by rights, envisaged by the present Law for scientific institutions.

Article 17. Public Scientific Organizations

Public scientific organizations shall be associations of scientists for task-oriented development of corresponding fields of science, protection of professional interests, mutual coordination of scientific and research activity, exchange of experience

Public scientific organizations shall be subject to registration according to the legislation on citizens' associations with taking into consideration of provisions of the present Law.

Public scientific organizations can found temporary scientific groups, establish research, designing, expert, consulting and investigation organizations for accomplishment of the statutory tasks, collaborate with the foreign and international organizations, to be member societies of international scientific-professional associations, unions, societies according to the current legislation of Ukraine.

Article 18. Relations of Government Authorities and Public Scientific Organizations

Government authorities can involve pubic scientific organizations upon their consent to participate in preparation and implementation of decisions regarding scientific and scientific and technology expertise, scientific and technology programs, projects and developments and jointly with them inform people concerning, safety, ecological cleanness, economic and social significance, ecological and socio-economic consequences taking place after implementation of the above mentioned programs, projects and developments.

Section III. STATE GUARANTEES OF SCIENTISTS' AND RESEARCH WORKERS' ACTIVITY

Article 19. Training of Research Personnel and their Skills Improvement

Postgraduate or doctoral departments shall be the principal forms of research personnel's training. Procedure of entering and training at the postgraduate department shall be set out by the Cabinet of Ministers of Ukraine.

Research workers shall pass practical study at the appropriate scientific state institutions and organizations in Ukraine and abroad.

Scientific institution shall provide for passing of the skills improvement course by the research scientist every five years with reservation of his/her average salary.

Results of skills improvement shall be taken into consideration during attestation of research workers.

Article 20. Scientific Degrees and Academic Titles

Scientists shall have right for obtaining a scientific degree of Candidate or Doctor of Science and awarding of the titles of Senior Research Assistant, Associate Professor and Professor.

Awarding of scientific degrees and academic titles shall be the state recognition of the scientist's level and qualification. Procedure for awarding of scientific degrees and academic titles shall be set out by the Cabinet of Ministers of Ukraine.

Certificates of Associate Professor and Professor shall be issued by the Ministry of Education of Ukraine, and diplomas of Candidate and Doctor of Science – by the Highest Attestation Commission of Ukraine.

Existence of appropriate scientific degree or academic title shall be a qualification requirement for taking by the research scientist of appropriate post.

Article 21. Attestation of Research Workers

Attestation of research workers shall be carried out at the scientific institutions at least once every five years with the purpose of:

evaluation of the research worker's professional level and effectiveness of his/her work;

determination of conformity of the research worker's qualification to the taken post;

determination of prospects for utilization of research worker's abilities, provision of incentives for his/her skills improvement;

determination of needs in skills improvement and professional training of research worker.

Regulation on attestation of research workers shall be approved by the Cabinet of Ministers of Ukraine.

Article 22. Legal Status of Scientific and Scientific and technology Result

Legal status of scientific and scientific and technology result as the legal object shall be determined by the Laws of Ukraine.

Article 221. Posts of Research Workers

The following shall be the posts of research workers, who work at scientific institutions and organizations (their branch offices, departments etc.):

Manager (President, General Director, General Designer, Director, Principal);

Manager Deputy (Vice-President, General Director, General Designer Deputies, Director, Principal Deputies) on research work;

Academician-secretary (his/her deputies);

Principal Academic Secretary, Academic Secretary (his/her deputies);

Manager (Head) and Deputy Manager (Deputy Head) of scientific subdivision (department, laboratory, sector, bureau, group);

General Designer, Senior Principal Engineer, Chief Technologist in principal field of activity of scientific institution, organization, establishment and their deputies;

Leading Designer, Leading Engineer, and Leading Technologist in principal field of activity of scientific institution, organization, and establishment;

Principal Research Worker;

Leading Research Worker;

Senior Research Worker;

Research Worker;

Research Worker-Consultant;

Junior Research Worker;

Doctoral Candidate.

Persons, holding scientific degree and working in their professional field according to the groups of specialties of the branch of science, in which the scientific degree was awarded, shall also be considered as research workers.

(the Law amended by adding Article 221 according to the Law of Ukraine No. 1316-IV dated November 20, 2003)

Article 222. Positions of Scientific and pedagogical Workers

Positions of science/pedagogic workers of higher educational institutions of 3rd - 4th accreditation levels shall be determined according to paragraph two of Article 48 of the Law of Ukraine "On Higher Education".

(the Law amended by adding Article 222 according to the Law of Ukraine No. 1316-IV dated November 20, 2003)

Article 223. Period of Scientific Work

The following periods shall be counted for period of scientific work:

period of work at the posts of research workers, determined by Article 221 of the present Law;

period of work at the posts of scientific/pedagogic workers of higher educational institutions of 3rd - 4thaccreditation levels, envisaged in part two of Article 48 of the Law of Ukraine "On Higher Education";

period of work for persons, holding scientific degree in their professional field according to the groups of specialties of the branch of science, by which the scientific degree was awarded beginning from the date of the above mentioned post's taking;

period of work of scientific (science/pedagogical) workers at the posts, specified in Article 118 of the Code of Laws on Labor of Ukraine, if this work has been preceded by work, envisaged by indents two, three and four of this Article;

period of study at the postgraduate department or adjunct department on full-time (regular) basis for the graduates of postgraduate or adjunct department.

(the Law amended by adding Article 223 according to the Law of Ukraine No. 1316-IV dated November 20, 2003)

Article 23. Remuneration and Incentive of Research Worker's Labor

Remuneration of research worker's labor shall provide sufficient economic conditions for effective, independent creative work, increment of research worker's prestige, motivate involvement of talented young people to research work and ensure research workers' skills improvement.

Salary of research workers shall consist of official salaries (labor rates), premiums, additional payments for scientific degrees and academic titles, increments for period of scientific (science/pedagogical) work and other increments, additional payments and remunerations for scientific (science/technology) activities, envisaged by the current legislation.

(paragraph two of Article 23 as amended by

the Laws of Ukraine No. 1646-III dated April 06, 2000, No.1316-IV November 20, 2003, No. 190-V September 22,.2006)

Lifelong payment shall be set out for the full and associate members of the Academy of Science of Ukraine and branch academies of science, the amount of the mentioned payment shall be determined by the Cabinet of Ministers of Ukraine.

The state guarantees setting labor rates (salaries) for the research workers of scientific institutions, financed at the cost of budget at the level, which is at least equal to the level of the labor rates (salaries) of the lecturers of appropriate qualification of higher educational institutions of the 3rd and 4th levels of accreditation.

The terms for remuneration of labor of scientific institutions' research workers shall be determined by the Cabinet of Ministers of Ukraine.

Article 24. Retirement and Social Security of Research scientist

The state sets out for research (science/pedagogical) workers, who have sufficient period of scientific work, pensions at the level, providing for prestige of scientific work and motivating for constant involvement of young scientists.

Pension for research (science/pedagogical) worker shall be granted upon achievement of retirement age:

for men – when length of service amounts at least to 25 years, provided that length of research work amounts at least to 20 years;

for women - when length of service amounts at least to 20 years, provided that length of research work amounts at least to 15 years.

Pensions for research (science/pedagogical) workers shall be set out in the amount of 80 percent of the salary of research (scientific/pedagogical) worker, determined according to Article 23 of the present Law and paragraph two of Article 40 of the Law of Ukraine "On Obligatory State Pension Insurance", which shall be subject to taxation for obligatory state pension insurance (fees).

(force of paragraph three of Article 24 is suspended for the year 2007 (regarding calculation of maximum amount of pension) according to the Law of Ukraine No. 489-V dated December 19, 2006)

For each full year of service above the period, determined by the paragraph two of the present Article, the sum of pension shall be increased by one percent, but cannot exceed 90 percent of the average monthly salary.

For calculation of pension the salary of research scientist at primary work location within any 60 consequent calendar months of scientific activities till July 01, 2000 regardless of interruptions and for the whole period from July 01, 2000 shall be taken into consideration.

At discretion of the person, who have applied for pension, the period up to 60 calendar consequent months could be excluded from the period, for which the pension shall be accrued, provided that the above mentioned period does not exceed 10 percent of the length of research work.

In any case, the period, for which the salary shall be accrued, with taking into consideration of exception, envisaged by the present Law, cannot exceed 60 calendar months.

The List of the posts of research (science/pedagogical) workers of the enterprises, establishments, organizations and scientific institutions of 3rd - 4th accreditation levels, holding of which gives right for granting of pension according to the present Article and payment of the financial assistance in the case of retirement according to the present Article, shall be approved by the Cabinet of Ministers of Ukraine with taking into consideration of Articles 221, 222 of the present Law.

Difference between the sum of pension, granted in conformity with the present Law and the sum of pension, for which the research scientist shall have right, calculated according to other legislative acts shall be financed:

for research (science/pedagogical) workers of state budget scientific institutions, organizations and higher educational institutions of 3rd - 4th accreditation levels – out of funds of the state budget;

for research (science/pedagogical) workers of other state enterprises, establishments, organizations and higher educational institutions of 3rd - 4th accreditation levels – out of funds of the above mentioned enterprises, establishments, organizations and institutions and out of the funds of the state budget according to the procedure, set out by the Cabinet of Ministers of Ukraine. In this case 50 percent of difference of pension, granted to one person according to the present Law, shall be paid to research (science/pedagogical) workers out of the state budget;

for research (science/pedagogical) workers of private scientific establishments, organizations and higher educational institutions of 3rd - 4th accreditation levels – out of funds of the above mentioned establishments, organizations and institutions.

Average salary of the employees, working in the fields of economy of Ukraine, including agriculture, shall be determined by the special authorized central executive authority in the field of statistics.

In this case income, taken for calculation of pension, cannot exceed the marginal sum of earning (income), which shall be taxed for obligatory state pension insurance.

Pensions, set out by the present Law, shall be indexed according to the legislation on indexation of people's monetary incomes.

In the case of increase of the sum of average salary in Ukraine within the previous year, according to the information submitted by the special central executive authority in the filed of statistics, the sum of the pension shall be increased annually from the 1st of March according to the procedure, set out by the paragraph two of Article 42 of the Law of Ukraine "On Obligatory State Pension Insurance".

Average monthly salary of research (science/pedagogical) workers of private scientific institutions, organizations and higher educational institutions of 3rd - 4th accreditation levels taken for calculation of pension, shall include the salary, received by the above mentioned workers during their work at the posts, specified in the List of the posts of research (science/pedagogical) workers of enterprises, establishments, organizations and higher educational institutions of 3rd - 4th accreditation levels, which give right for granting of pension and payment of financial assistance in the case of retirement in conformity with the present Article, approved by the Cabinet of Ministers of Ukraine, provided that thee sum of the pension shall not exceed:

for managers and/or deputy managers of private scientific establishments and organizations – maximum sum of the salary (labor rate) of the manager and/or deputy manager of scientific-research institution of the National Academy of

Science of Ukraine with taking into consideration of additional payment for scientific degree and increment for the period of scientific activities according to the current legislation, calculated on the basis of maximal amount of the salary (rate), and for managers and/or deputy managers of private higher educational institutions of 3rd - 4th accreditation levels – maximum sum of the salary (labor rate) of rector, pro-rector of corresponding state higher educational institution of 3rd - 4th accreditation level with taking into consideration of additional payment for scientific degree and increment for the period of scientific activities according to the current legislation, calculated on the basis of maximal amount of the salary (rate);

for other research workers of private scientific institutions, organizations and establishments - maximum sum of the salary (labor rate) of the Senior Researcher of scientific-research institution of the national Academy of Science of Ukraine with taking into consideration of additional payment for scientific degree and increment for the period of scientific activities according to the current legislation, calculated on the basis of the mentioned maximum sum of the salary (labor rate), and for scientific and pedagogical workers of private higher educational institutions of 3rd - 4th accreditation levels - maximum sum of the salary (labor rate) of the similar posts of corresponding state higher educational institution of 3rd - 4th accreditation levels with taking into consideration of additional payment for scientific degree and increment for the period of scientific activities according to the current legislation, calculated on the basis of maximal amount of the salary (rate).

Provisions of the present Article shall be applied also to the pensioners, who belong to research workers, whose pension was granted before coming into force of the present Law.

Pension of research (science/pedagogical) according to the present Law shall be granted from the date of application for granting of the pension and provided that he/she is dismissed form the post of research (science/pedagogical) worker, except the persons, who work according to the terminal labor agreement (contract), which has been signed after achievement of retirement age.

The sum of the pension for persons, who after granting thereof pursuant to the present Law, worked according to the terminal labor agreement (contract) at the posts of research (science/pedagogical) workers at least for the period of two years, shall be recalculated with taking into consideration of the period of scientific work after granting of pension. Recalculation of the pension shall be carried out on the basis of the salary of research (science/pedagogical) worker, taken for calculation of the pension or on the basis of the salary, determined according to the procedure, envisaged by paragraphs three-seven of the present Article.

Right for granting of the pension pursuant to the present Law shall be applied also to the persons, who as at the moment of application for granting of pension take any post at the enterprises and/or organizations of all types of ownership and whose period of scientific work is envisaged by paragraph two of present Article.

After retirement of research (science/pedagogical) worker pursuant to the present Law, research (science/pedagogical) worker shall be provided with monetary assistance in the amount of six monthly salaries (labor rates) with taking into consideration of increments and additional payments, provided that he/she has been worked at the posts, specified in the List of the posts of research (science/pedagogical) workers of the enterprises, establishments, organizations and scientific institutions of 3rd - 4th accreditation levels, holding of which gives right for granting of pension according to the present Article and payment of the financial assistance in the case of retirement according to the present Article, approved by the Cabinet of Ministers of Ukraine, at least:

for men - 12,5 years;

for women - 10 years.

Disability pension in a result of work injury or occupational disease and/or in a result of injury caused by Chernobyl accident shall be granted to a research (science/pedagogical) worker in the amount:

for the disabled persons of the 1st group - 80 percent of the salary of research (science/pedagogical) worker;

for the disabled persons of the 2nd group - 60 percent of the salary of research (science/pedagogical) worker;

for the disabled persons of the 3rd group - 40 percent of the salary of research (science/pedagogical) worker.

Research (science/pedagogical) workers, who have disability of 1st, 2nd, 3rd groups, shall be provided with the disability pension in the amount of pension of research (science/pedagogical) worker regardless of age, and provided that their length of service is in conformity with the paragraph two of the present Article.

Pension for lost of breadwinner shall be granted to the incapable family members of decedent scientific (science/pedagogical) worker (breadwinner), supported by him/her (in this case children shall be provided with pension regardless of whether they were supported by the breadwinner or not) in the amount:

80 percent of pension of scientific (science/technology) worker – for three and more incapable family members;

60 percent – for two incapable family members;

40 percent – for one incapable family member.

Persons, specified in Article 36 of the Law of Ukraine “On Obligatory State Pension Insurance” shall belong to the incapable family members of decedent research (science/pedagogical) worker.

Right for granting of pension pursuant to the present Law shall apply to all persons, who were retired until coming into legal force of the present Law and whose period of scientific work is in compliance with the provisions of paragraph two of this Article. Pensions to the above mentioned workers shall be granted according to paragraphs three-seven of this Article from the day of application for pension and provided that the above mentioned persons shall be dismissed form the post of research (science/pedagogical) worker, except the persons, who work according to the labor agreement (contract), signed after achievement of retirement age.

Right for granting of pension pursuant to the present Law shall also apply to the incapable family members of research (science/pedagogical) worker, who has died before coming into force of the present Law. Pension shall be set out in the amount, envisaged by the paragraph twenty two of this Article.

For those persons, who hold the posts, belonging according to the current legislation to the posts of public officers, previous period of scientific work at state scientific institutions, organizations and establishments shall be included to the period of public service regardless of interruptions, and for those persons, who held (hold) the posts of research (science/pedagogical) workers, previous period of scientific work shall be included to the period of scientific work regardless of interruptions.

Pension of research (science/pedagogical) worker shall be paid in full, regardless of his/her incomes, received after retirement.

force of paragraph twenty seven of Article 24 is suspended for the year 2007 (regarding amount of pension, which shall be paid) according to the Law of Ukraine No. 489-V dated December 19, 2006)

For research workers, who have made significant contribution to development of science, state grants could be set out, and for support of talented young people – grants for young scientists according to the current legislation.

Research workers, holding scientific degree of Candidate or Doctor of Science for ensuring scientific labor conditions shall be provided according to the procedure, established by the current legislation, with additional dwelling space in the form of room (library) or amounting to 20 sq. m. The above mentioned dwelling space shall be paid at the normal rate.

Scientific organizations and institutions can provide service housing for separate categories of research (science/pedagogical) workers (according to the list, approved by the special executive authority in the filed of education and science and/or presidiums of the National and branch Academies of Science).

This Article shall be applied to research (science/pedagogical) workers of private scientific institutions and organizations, which have passed state attestation according to the present Law, private higher educational institutions of 3rd - 4th accreditation levels, acting according to the Law of Ukraine “On Higher Education”, international scientific organizations, opened at the territory of Ukraine according to the international agreements, statutory documents of which are approved by the Cabinet of Ministers of Ukraine, and to research (science/pedagogical) workers of scientific institutions and higher educational institutions of 3rd - 4th accreditation levels, which belonged to former party and public organizations of former Ukrainian Soviet Socialist Republic, other republics of USSR and of USSR.

(Article 24 as amended by the Law of Ukraine No. 1646-III dated April 06, 2000, amended according to the Laws of Ukraine No. 2905-III dated December 20, 2001, No. 380-IV dated December 26, 2002, as amended by the Law of Ukraine No. 1316-IV dated November 20, 2003, amended according to the laws of Ukraine

No. 1344-IV dated November 27, 2003, No. 2094-IV dated October 19, 2004, No. 3108-IV dated November 17, 2005, as amended by the Law of Ukraine No. 190-V dated September 22, 2006)

Section IV. POWERS OF THE SUBJECT OF STATE REGULATION AND ADMINISTRATION IN THE FIELD OF SCIENTIFIC AND SCIENTIFIC AND TECHNOLOGY ACTIVITIES

Article 25. Powers of the Verkhovna Rada of Ukraine in the field of scientific and scientific and technology activities

The Verkhovna Rada of Ukraine shall:

exercise state regulation in the field of scientific and scientific and technology activities;

determine major principles and directions of the state policy in the field of scientific and scientific and technology activities;

approve priority directions of science and technology development and national programs of scientific and technology development of Ukraine;

(indent four of Article 25 amended according to

the Law of Ukraine No. 3421-IV dated February 09, 2006)

exercise other powers, which belong to its competence according to the Constitution of Ukraine.

Article 26. Powers of the President of Ukraine in the Field of Scientific and Scientific and technology Activities

The President of Ukraine as the Head of the State and guarantor of its state sovereignty provides for development of science and technology in order to provide technological independence of the state, prosperity of society and spiritual development of the nation.

The President of Ukraine according to the Constitution of Ukraine:

shall determine the system of executive authorities, which exercise state administration in the field of scientific and scientific and technology activities in Ukraine;

shall provide for control of forming and operation of the state administrative system in the field of scientific and scientific and technology activities;

in order to exercise entrusted powers in the scientific and scientific and technology fields shall establish consultative-advisory council in the filed of scientific and scientific and technology policy, which shall contribute to forming of the state policy concerning development of science, determination of priority for scientific-technological directions, elaboration of the strategy of science/technological and innovational development, shall consider proposals concerning effective utilization of funds of the State Budget of Ukraine, which shall be directed at the development of science, technology and innovations for improvement of the structure of science administration and of the system of training and attestation of the personnel.

Article 27. Powers of the Cabinet of ministers of Ukraine in the Field of Scientific and Scientific and technology Activities

Cabinet of Ministers of Ukraine as supreme body in the system of executive authorities:

shall carry out scientific and technical policy of the state;

shall submit to the Verkhovna Rada of Ukraine proposals regarding priority directions of science and technology development and its material and technical support;

shall provide for implementation of the state target scientific-technology programs;

(indent four of Article 27 amended according
to the Law of Ukraine No3421-IV dated February 09, 2006)

shall approve within its competence the state target scientific-technology programs in conformity with the priority directions of science and technology development, set out by the Verkhovna Rada of Ukraine.

(indent five of Article 27 amended according
to the Law of Ukraine No. 3421-IV February 09, 2006)

Article 28. Powers of the Central Executive Authority in the Field of Scientific, Scientific and technology and Innovation Activities

Central executive authority in the field of scientific, scientific and technology and innovation activity is a central executive authority, providing for implementation of the state policy in the field of scientific and scientific and technology activities.

Central executive authority in the field of scientific, scientific and technology and innovation activity:

shall develop the principles of scientific and scientific and technology development of Ukraine;

shall provide for development of scientific and scientific and technology potential of Ukraine;

shall organize and coordinate innovation activity;

shall coordinate development of the national system of scientific and technology information;

shall organize forecast-analytical research of trends of scientific and technology and innovation development;

(paragraph two of Article 28 was amended by indent six according to the Law of Ukraine No. 2261-IV dated December 16, 2004)

shall form priority directions of science, technology and innovation activity development on the basis of the long-term (more than ten years) and medium-term forecasts of scientific and technology and innovation development;

(paragraph two of Article 28 is amended by adding new indent seven according to the Law of Ukraine No. 2261-IV dated December 16, 2004, thereby indent six - nine shall be considered correspondingly indents eight-eleven)

shall coordinate activity of the executive authorities concerning development of the state target scientific and scientific and technology programs, scientific parts of other target programs and shall control fulfillment thereof;

(indent eight of paragraph two of article 28 as amended by the Law of Ukraine No. 3421-IV dated February 09, 2006)

shall administer the system of scientific and scientific and technology expertise;

shall provide for integration of national science into the worldwide scientific space, preserving and protecting national priorities;

shall exercise other powers, envisaged by the current legislation of Ukraine.

Article 29. Powers of other Central Executive Authorities in the Field of Scientific and Scientific and technology Activities

Other central executive authorities within their powers shall:

exercise administration in the field of scientific and innovation activity and be responsible for the level of scientific and technology development of the corresponding branches;

determine the tendencies of scientific and science technological potential of branches, direct and control activity of subordinated scientific organizations;

participate in forming of priority directions of science and technology development in Ukraine, state target scientific and scientific and technology programs f state order;

(indent four of Article 29 amended by the Law of Ukraine No. 3421-IV dated February 09, 2006)

form the programs of science/technological development of corresponding branches and organize fulfillment thereof;

organize elaboration, development and production of current competitive products on the basis of new high-efficiency technologies, installations, materials and information support;

prepare proposals concerning improvement of economic mechanism for ensuring of scientific and technology development of the corresponding branches;

exercise other powers, envisaged by the current legislation of Ukraine.

Article 30. Powers of the Verkhovna Rada of Autonomous Republic of Crimea, Local Councils, Council of Ministers of the Autonomous Republic of Crimea, Local Executive Authorities

Verkhovna Rada of the Autonomous Republic of Crimea, local councils, council of ministers of the Autonomous Republic of Crimea, local executive authorities regarding scientific and science/technical activity according to their competence shall:

provide for implementation of the target scientific and scientific and technology programs;

(indent two of Article 30 amended according

to the Law of Ukraine No. 3421-IV dated February 09, 2006)

elaborate and organize implementation of regional (territorial) programs of scientific and technology development;

establish local innovational funds in accordance to the current legislation of Ukraine;

contribute to development of industrial parks, technopolises and innovative business incubators;

involve appropriate scientific institutions (upon their agreement) for solving of the problems of scientific/technology development of a region.

Section V. FORMS AND METHODS OF STATE REGULATION AND ADMINISTRATION IN THE FIELD OF SCIENTIFIC AND SCIENTIFIC AND TECHNOLOGY ACTIVITIES

Article 31. Tasks and Directions of the State Policy in the Field of Scientific and Scientific and technology Activities

Major tasks of the state policy in the field of scientific and scientific and technology activities shall be:

augmentation of national wealth on the basis of implementation of scientific and scientific and technology achievements;

creating conditions for achievement of a high living standard of each citizen, his/her physical, spiritual and intellectual development due to implementation of the current achievements of science and technology;

promotion for national security on the basis of implementation of scientific and scientific and technology achievements;

ensuring free development of scientific and scientific and technology creative activity.

The state shall provide:

socioeconomic, organizational and legal conditions for forming and effective implementation of scientific and scientific and technology potential, including state support of the subjects of scientific and scientific and technology activity;

establishment of the current infrastructure of science and system of informational support of scientific and scientific and technology activity, integration of education, science and industry;

training, skills improvement and retraining of scientific personnel;

increase prestige of scientific and scientific and technology activity, support and motivation of young scientists;

financing and material support of fundamental researches;

organization of forecasting of scientific and scientific and technology development tendencies for long-term and medium-term periods;

(paragraph two of Article 31 is amended by adding new indent seven according to the Law of Ukraine No. 2261-IV dated December 16, 2004, thereby indents seven-fourteen shall be considered as indents eight-fifteen)

support of priority direction of science and technology development, state target scientific and scientific and technology programs and concentration of resources for their implementation;

(indent eight of paragraph two of Article 31 amended according to the

Law of Ukraine No. 3421-IV dated February 09, 2006)

creation of the market of scientific and scientific and technology products and implementation of achievements of science and technology into all fields of social life;

legal defense of intellectual property and creation conditions for its effective implementation;

organization of statistics in scientific activity;

carrying out scientific and scientific and technology expertise of manufacture, new technologies, equipment, results of research, scientific and technology programs and projects etc.;

provision of incentives for scientific and scientific and technology creative activities, inventions and innovation activities;

promotion of scientific and scientific and technology achievements, inventions, new current technologies and contribution of Ukraine in development of the world science and technology;

establishment of mutually profitable relations with other states for integration of national and world science.

Article 32. Major Principles of State Administration and Regulation in the Field of Scientific and Scientific and technology Activities

In exercising of state administration and regulation of scientific activity the state shall be guided by the following principles:

seamless integration of science/technology, economic, social and spiritual society development;

combination of centralization and decentralization of administration in the field of scientific activity;

adherence to the requirements of ecological safety;

recognition of freedom in carrying out of creative, scientific and scientific and technology activity;

balance of fundamental and applied researches development;

implementation of achievements of the world science, possibilities of international scientific collaboration;

freedom for distribution of scientific and scientific and technology information;

openness for international scientific and technology collaboration, provision for integration of Ukrainian science into the world science along with protection of the national security interests.

Article 33. Financial-Credit and Tax Levers for State Regulation in the Field of Scientific and Scientific and technology Activities

The state shall apply financial-credit and tax levers for creation of economically favorable conditions for effective carrying out of scientific and scientific and technology activities according to the current legislation of Ukraine.

Article 34. Budget Financing of Scientific and Scientific and technology Activities

Budget financing is one of the major levers for implementation of the state policy in the filed of scientific and scientific and technology activities.

The state shall provide for budget financing of scientific and scientific and technology activities (besides expenses for defense) in the sum, that amount at least to 1,7 percent of the gross domestic product of Ukraine.

Expenses for scientific and scientific and technology activities shall be protected items of expenditure of the State Budget of Ukraine.

Budget financing of scientific researches shall be carried out by means of basic and program-target financing.

Basic financing shall be provided for ensuring:

fundamental scientific researches;

the most important for the state directions of researches, including researches for provision of national security and defense;

development if scientific and scientific and technology development infrastructure;

protection of scientific facilities, which constitute national endowment;

training of research personnel.

The list of scientific institutions and higher educational institutions, provided with basic financing for carrying out of scientific and scientific and technology activities shall be approved by the Cabinet of Ministers of Ukraine.

Program-target financing, as a rule, shall be provided on a competitive basis for:

scientific and technology programs and separate projects, focused on implementation of priority directions of science and technology development;

ensuring of carrying out of the most important applied scientific and technology developments, which shall be implemented according to the state order;

projects, accomplished in frames of international scientific and technology collaboration.

Budget financing of scientific and scientific and technology activities shall be rendered according to the current legislation of Ukraine.

Article 35. State Fund of Fundamental Research

With a view to support fundamental scientific researches in the field of natural and humane sciences, carried out by scientific institutions, higher educational institutions and scientists, the State fund of fundamental researches (named hereinafter to as Fund) shall be established.

Activity of the Fund shall be regulated by the Regulation, approved by the Cabinet of Ministers of Ukraine.

The resources of the Fund shall be specified by separate line in the State Budget of Ukraine.

The resources of the Fund shall be formed form:

budget funds;

voluntary contributions of legal entities and individuals (including the foreign ones).

The resources of the Fund shall be distributed on a competitive basis.

Article 36. State Target Scientific and Scientific and technology Programs in the Field of Scientific and Scientific and technology Activities

State target scientific and scientific and technology programs shall be the principle way of implementation of the priority directions of science and technology development by means of state's scientific and technology potential concentration with a view to solve the most important natural, technological and humane problems.

State target scientific and scientific and technology programs in priority directions of science and technology development shall be formed by the central executive authority in the field of scientific, scientific and technology and innovational activities on the basis of the target projects, selected on a competitive basis.

(Article 36 as amended by
the Law of Ukraine No. 3421-IV dated February 09, 2006)

Article 37. State Order for Scientific and technology Products

State order for scientific and technology products shall be formed on annual basis by the central executive authority in the field of scientific, scientific and technology and innovational activity and by the central executive authority in the field of economic policy on the basis of the list of the most important developments, aimed at creation of the advanced technologies and products and shall be approved by the Cabinet of Ministers of Ukraine according to the current legislation of Ukraine.

Article 38. State Innovation Fund

With a view to ensure financing of the state policy implementation in the filed of scientific and scientific and technology activities and carrying out of measures aimed at development and application of scientific achievements in Ukraine, the State Innovation Fund shall be established, regulation on which shall be approved by the Cabinet of Ministers of Ukraine.

State Innovation Fund shall be subordinated to the central executive authority in the field of scientific and scientific and technology activities.

State Innovation Fund on a competitive basis shall render financial, material and technical support of measures, aimed at manufacturing application of priority scientific and technology developments and advanced technologies, technical re-equipment of industry, introduction of new competitive products.

The resources of the State Innovation Fund shall be formed from the fund fees, set out by the current legislation of Ukraine and from the extra-budgetary funds, received in a result of repayment of loans, investments, leasing payments, incomes obtained in a result of joint activity with performers of innovational projects, voluntary contributions of legal entities and individuals and other incomes, that do not contradict to the current legislation of Ukraine.

(force of paragraph four of Article 38 is suspended for the year 2002 according to the Law of Ukraine No. 2905-III dated December 20, 2001, for the year 2003 – according to the Law of Ukraine No. 380-IV dated December 26, 2002, for the year 2004 - according to the Law of Ukraine No. 1344-IV dated November 27, 2003)

Article 39. Ensuring of Scientific Human Resources Development

With a view of on-going renewal of society’s intellectual potential development and diffusion of scientific and technological culture, development of innovations, support of creative work of research and scientific and technology workers the state shall:

ensure increment of scientific labor prestige;

organize training and skills improvement of research and science/technical personnel at state scientific and educational institutions;

ensure search and selection of talented youth, contributes to their probation;

contribute to training and retraining of research and scientific and pedagogical personnel outside Ukraine;

implement the system of personnel attestation and contribute to recognition of diplomas on higher education, scientific degrees and academic titles at the transnational level;

establish benchmark for scientific and scientific and technology knowledge for educational programs in each level of education.

Article 40. Scientific and Scientific and technology Expertise

Scientific and scientific and technology expertise is an integral part of state regulation and administration in the field of scientific and scientific and technology activities and shall be carried out according to the Law of Ukraine “On Scientific and Scientific and technology Expertise”.

Article 41. System of Scientific and technology Information

With a view to ensure science development and contribute to scientific and technology creative work the state shall establish the system of scientific and technology information, functioning and development of which shall be regulated by the current legislation of Ukraine.

Article 42. Intellectual Property Rights Protection

Intellectual property rights protection shall be ensured according to the laws and other regulatory legal acts of the governmental authorities of Ukraine.

In the case of violation of intellectual property right it shall be protected according to the procedure, set out by administrative, civil and criminal legislation.

Determination of the intellectual right-holders, liabilities of the parties regarding ensuring of the rights’ for created intellectual property objects protection, determination of the party, which shall pay remuneration to the intellectual right-holders according to the current legislation of Ukraine, shall be mandatory requirement for the agreement (contract), on the basis of which scientific/research and scientific/designing works, financed out of the State Budget of Ukraine shall be carried out.

(Article 42 as amended by
the Law of Ukraine No. 1407-IV dated February 03, 2004)

Article 43. Standardization, Metrological Support and Certification in the Field of Scientific and Scientific and technology Activities

Standardization, metrological support and certification in the field of scientific and scientific and technology activities shall be carried out according to the current legislation of Ukraine.

Article 44. State Support of International Scientific and Scientific and technology Collaboration

The state shall provide for necessary legal and economic conditions with a view to ensure for the subjects of scientific and scientific and technology activities free and equal relations with scientific and scientific and technology organizations, foreign legal entities, international scientific organizations, foreign and international scientific societies and associations, if the above mentioned relations do not contradict to the current legislation of Ukraine.

International scientific and scientific and technology collaboration shall be carried out by means of:

implementation of joint scientific researches, technical and technological developments n the basis of cooperation, joint scientific and technology programs;

carrying out studies and developments according to the joint coordination agreements;

accomplishment of works, envisaged by the agreement, where foreign or international organization is a part;

joint studies and developments within international groups of specialists, international institutes and joint ventures, use of property for obtaining of scientific and scientific and technology result on the basis of agreements between the subjects of scientific and scientific and technology activities;

mutual exchange of scientific and scientific and technology information, utilization of joint informational funds and data banks;

carrying out of international conferences, congresses, symposiums;

mutual exchange of scientific, scientific and technology and teaching personnel, students and postgraduate students, scientific specialists' training.

Subjects of scientific and scientific and technology activities could participate in implementation of international programs and projects, sign agreements with foreign organizations and legal entities, to participate in activity of foreign and international scientific societies, associations and unions as the members thereof, to sign agreements with foreign organizations and legal entities, to participate in the international symposiums and other events according to the current legislation of Ukraine.

Central executive authority in the filed of scientific, scientific and technology and innovational activities shall carry out state registration of international scientific and technology programs and projects, implemented in frames of international scientific and technology collaboration by Ukrainian scientists and issue of grants in frames of the above mentioned collaboration according to the procedure, established by the Cabinet of Ministers of Ukraine.

Limitations in the filed of international scientific and scientific and technology collaboration shall be set out by the current legislation of Ukraine.

Section VI. FINAL PROVISIONS

1. The present Law shall come into force beginning from the date of publishing thereof, except for articles 11, 12, 13, 14, 15, 19, 20, 21, 23, 24, 34, 36, which shall come into force within six months after coming into force of the present Law.

2. Cabinet of Ministers of Ukraine shall:

provide within the term of six month adoption of regulatory legal acts, envisaged by the present Law;

bring its regulatory legal acts into conformity with the present Law.

3. Until brining the legislation of Ukraine into conformity with the present Law, the laws and other regulatory legal acts shall be applied in the part, which does not contradict to the present Law.

4. Funds, necessary for implementation of provisions of paragraph four and seven of Article 24 of the present Law, shall be envisaged in section “Fundamental Scientific Researches and Assistance to Scientific and technology Progress” of the State Budget of Ukraine.

5. Paragraph two of Article 34 of the present Law shall be implemented on a staged basis from 1999 till 2001 by means of increase on annual basis of the expenses, allocated for science, beginning with one percent of gross domestic product.

4. Research studies and reporting

The following steps are recommended for conducting and reporting scientific research:

1. Formulation of the Research problem: The starting point of most new researches is to formulate a general research problem and ask basic questions concerning the issue under research. This will elicit curiosity to proper definition of the salient points of the investigation.

2. Review of Relevant Literature: A literature review is a critical examination of existing

works in a field under research. The critical dimension of this definition implies that the reviewer is interested in discovering contributions made in the field as well as identifying gaps or limitations, which exist. Berger, (2010), opines that one of the major functions of synthesis of related literature is to let the reader known that the researcher is thoroughly familiar with the existing research materials on the subject, it provides the back-drop or the scenery for the study and gives that the researcher is not yet at a dead end. It also clearly shows the current state of knowledge on the subject.

3. Formulation of Research Hypotheses: Eventually, the researcher will arrive at fundamental hypotheses formulation around which the study will be based by making tentative assumptions or statements of the relationship between two or more variables. Research hypothesis is very necessary in any scientific research (especially in quantitative research).

4. Determination of the Research Design: This stage of the scientific research involves designing the approach or strategy that will guide in collection of data for the study.

5. Sampling methods and Sample Selection: Samples are selected by using statistical means, so as to ensure an even selection of the subject involved and thus avoid biasness in selection. Representativeness is essential because the result of the study, which is derived from the sample selection made, will be used ultimately to generalize its effect on the entire population. The procedure adopted for obtaining a sample from the population is categorized into two. These are probability or randomized and non-probability or non-randomized sampling methods. These two categories have their sub-divisions, where each division has its specific steps for arriving at the desired selection.

Asika, (1999) gives a simplified tabular model of the different methods involved in sample design as follows:

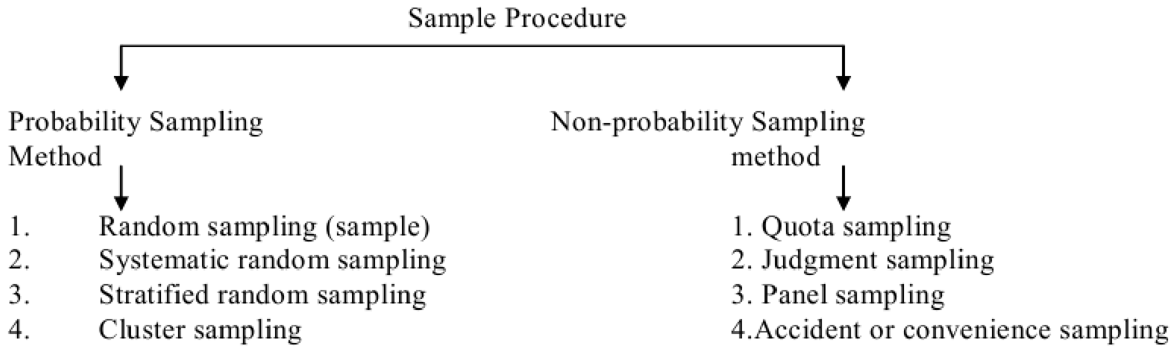

Figure: Sample Procedure

6. Data Collection Techniques: Data collection is the process of gathering data from either the primary or secondary sources for the purpose of the study analysis. The primary sources consist of first-hand information or raw data obtained by the researcher himself through the administration of research instruments. The secondary sources are existing data obtained from relevant materials such; books, journals, magazines and so on an unpublished work of others as well as valuable documents available to the researcher. Anayo and Uche (2002) list two main methods of collecting research data namely: Survey methods; and Non-survey methods. The survey method of data collection is one that entails a direct contact between the researcher and the subjects during which the researcher asks questions, which the subjects answer. The non-survey method, on the other hand, is one in which data are collected about subjects without necessarily involving any direct contact between the researcher and the subjects. For instance, using experiments, observation, case studies and document studies to collect data.

7. Methods of Data Analysis and Presentation: The scope of the research begins to broaden again, as statistical analyses are performed on the data, and it is organized into an understandable form. The answers given by this step allow the further widening of the research, revealing some trends and answers to the initial questions.Analysis may be defined as the breaking and ordering of the quantitative information gathered for research purposes. It also involves searching for trends and patterns of associations and relationships among these data or groups of them.

8. Discussion and Interpretation of Findings: This step deals with analytical discussions in relation to the data and information elicited from the study. The discussion concentrates on the findings and comparative analysis of data and expectations; and, deductive inferences. It corroborates or rejects earlier positions of literature reviewed, discusses how it has been able to fill the gap which the present research sets out to fill and the contributions it makes to knowledge and human development. Anayo and Uche (2002) refer to the interpretation of research findings as a key component and one of the most important aspects of the research process. A research process becomes useless to policy making or planning if its outcome cannot be properly analyzed and interpreted. For the purpose of analysis and interpretation of research findings, the users of such findings must be made to understand the important indication and statistics reported in research findings and how to use them in interpreting the research findings.

9. Writing the research Report: A report is a formal statement of the result of a scientific research or an investigation or of any subject in respect of which certain information is required, and is written by a person or body charged for this purpose, (Berger, 2010). Report writing is a specialized form of communication and it is of different types and kinds. Apart from the type report required from students in examinations, which is purely for a specific purpose, the other types are research or survey reports such as those found in academic, and commercial or business environments. For examination and business purposes, there are short, long and very long reports that range from simple and fairly complex to those technical in nature. A good report must therefore be completely readable and formal in tone. The language used must conform to the expected standard and style or custom of the body concerned.

10. Summary, Conclusion and Recommendations: This consists of a short summary of the whole work. It highlights the major findings, implications in the areas of existing situation and further research, policy formulations and implementation and theoretical implications. The conclusion is drawn from the findings of the study and this forms the theme of the policy recommendations and implications. Recommendations are often times made based on the projections and predictions from the findings of the study.

11. Bibliography and References: This contains a list of all the books and referred materials consulted in course of the research project. Bibliography refers to both consulted and related works and documents to the project work while references refer to the consulted works made in course of the present investigation. It is appropriate to list the references or consulted literature in alphabetical order, starting with the surnames of authors, then the initial(s) or full names depending on format and requirements, date of publication, etc.

12. Appendices: Includes attachments and enclosures and which are put at the end of the project work. They include copies of questionnaires, interview schedule and guides, tables, photographs, maps, etc. In some publications, tables are inserted as they appear within the pages of the work.

5. Report on a scientific topic or message and general requirements to them

Writing a Scientific Report

A scientific report **is a document that describes the process, progress, and or results of technical or scientific research or the state of a technical or scientific**

research problem. It might also include recommendations and conclusion of the research.

Page contents

- Elements of a Scientific Report
- Scientific Reports for Employers or Clients
- References

Elements of a Scientific Report

1. Title Page
2. Table of Contents
3. Abstract
4. Introduction
5. Materials and Methods (Experimental)
6. Results
7. Discussion
8. Conclusion
9. References

Title page

The title page will include the following:

- Title of the report:
  - Usually 4-12 words in length.
  - Should be short, specific and descriptive, containing the keywords of the report.
- Authorship:
  - Always publish under the same name.
  - Include author addresses.
  - Indicate the corresponding author and their contact details.
- Date:
  - The date when the paper was submitted.

Table of Contents

A Table of Contents is only required for length reports (usually 6 pages or more).

Abstract

The Abstract is a self-contained synopsis of the report - an informative summary of what you did and what you found out.

The Abstract should include the following:

- Objectives (as outlined in the Introduction) and scope of the investigation.
- A brief reference to the Materials and Methods.
- A summary of the results and conclusions - a brief but thorough statement of the outcome/s of the experiment.

If there is a hypothesis, you may state what it is and whether it was supported or refuted.

The following should not be included in the Abstract:

- Literature citations.
- Formulae and abbreviations, references to tables.

Although the Abstract comes first in a report, it is best to write it last, after you have the results and conclusions.

Introduction

This provides a summary of the analysis to be undertaken. The purpose of the Introduction is to put the reader in the picture and place the research/experiment within a context.

The following may be included in the Introduction:

- Background about the analysis to be carried out.
- A brief review of previous research (relevant literature) to give a background - paraphrase relevant facts from the scientific literature, citing the sources to support each statement.
- Reason/s why the research was undertaken.
- Statement of the hypothesis (an idea or concept that can be tested by experimentation) if there is one.
- An explanation of the different techniques and why they are used.
- A statement of the objective/s - what you hope to achieve.

The Introduction is the what and why of the experiment, and should answer the following questions:

- What was the purpose or objective of the experiment/research?
- Why was the experiment/research conducted in a particular manner?
- Why was it important in a broader context?

The Introduction should not include any results or conclusions.

Materials and Methods (Experimental)

The Materials and Methods, sometimes called Experimental, is a description of the materials and procedures used - what was done and how. Describe the process of preparation of the sample, specifications of the instruments used and techniques employed.

The Method should include such things as sample size, apparatus or equipment used, experimental conditions, concentrations, times, controls etc.

While the Method does not need to include minute details (e.g. if you followed a set of written instructions, you may not need to write out the full procedure - state briefly what was done and cite the manual), there needs to be enough detail so that someone could repeat the work.

Do not keep using the word "then" - the reader will understand that the steps were carried out in the order in which they are written.

The Method must be written in the past tense and the passive voice.

Results

This section states what you found.

The following will be included in your Results:

- Pictures and spectra.
- Tables and graphs whenever practical.
- Brief statements of the results in the text (without repeating the data in the graphs and tables). When writing about each picture, graph or table, refer to it parenthetically e.g.

- If possible give a section of related results and then comment on them rather than presenting many pages of unrelated results and then discussing them at the end. Subheadings can be used to divide this section so that it is easier to understand.

Massive quantities of data or raw data (not refined statistically) can be presented in appendices.

Include only your own observed results in this section.

The following should not be included in your results:

- What you expected to find or what you were supposed to have observed.
- References to other works (published data or statements of theory).

Use the Discussion section of the report for these.

The Results section should be written in the past tense and passive voice, avoiding the use of "I" and "we".

Discussion

State your interpretation of your findings, perhaps comparing or contrasting them with the literature. Reflect on your actual data and observations.

Explain or rationalise errant data or describe possible sources of error and how they may have affected the outcome.

The Discussion must answer the question "What do the results mean?" It is an argument based on the results.

Conclusion

This is the summing up of your argument or experiment/research, and should relate back to the Introduction.

The Conclusion should only consist of a few sentences, and should reiterate the findings of your experiment/research.

If appropriate, suggest how to improve the procedure, and what additional experiments or research would be helpful.

References

Cite any references that you have used, ensuring that each item in the reference list has an in-text citation, and every in-text citation has a full reference in the reference list at the end of your paper.

Ensure that the references are formatted according to the style required by the journal (or your lecturer/supervisor), and be careful with spelling (the author whose name you misspell may be asked to review the paper!)

Scientific Reports for Employers or Clients

If a scientific report is being prepared for an employer or client, the following additional elements may be included:

Covering Letter or Memo

A formal covering letter (if the the report is for someone outside your organisation) or memo (if the report is for someone within your organisation) which accompanies the report will include the following:

- Identification of the report topic.
- Identification of the person authorising the report, and date of authorisation.

- Key findings.
- Acknowledgement of any assistance received.

Executive Summary

This would be situated at the beginning of the report (before the Abstract). The Executive Summary will

- explain the purpose of the report.
- describe the methods used in the investigation.
- give the main conclusions and recommendations (if applicable).

Because the readers of the report will not necessarily be scientists, the Executive Summary should be in simple language, avoiding the use of technical jargon.

Recommendations

If the report is of an investigative nature, the final section (after Conclusion) will be any recommendations that you make on the basis of the scientific results.

Acknowledgements

If other people or organisations assisted in any way with the experiments/research (e.g. funding, facilities, guidance etc.), they should be thanked at the end of the document (after Conclusion and Recommendations).

6. Structure and stages of the dissertation work

General Structure dissertation

Like an academic paper for journal publication, dissertations generally follow a fairly standard structure. The following pages discuss each of these in turn, and give more detailed advice about how to prepare and write each one:

- **Research Proposal**
- **Introduction**
- **Literature Review**
- **Methodology**
- **Results and Discussion**
- **Conclusions and Extra Sections**

Particularly for master's programmes, your university may ask for your thesis to be submitted in separate sections, rather than as a single document. One breakdown that is often seen is three-fold:

- **Introduction and/or Research Proposal**, which should set out the research question that you plan to explore and give some ideas about how you might go about it. If you are submitting it as a research proposal, it will be fairly sketchy as you won’t have had a chance to review the literature thoroughly, but it should contain at least some theoretical foundation, and a reasonable idea of why you want to study this issue;
- **Literature Review and Methodology**, which are often combined because what you plan to do should emerge from and complement the previous literature; and
- **Results and Discussion**, which should set out what you actually did, the results you obtained, and discuss these in the context of the literature.

Warning!

You will probably have an overall word count for the total dissertation or thesis. If you are required to submit in sections, ensure that you have left yourself enough words for the Results and Discussion. It is easy to get carried away with the literature review.

As a general guide, use the marking scheme to show you the approximate split for the word count. For example, if the introduction is worth 20%, and each of the other two submissions 40%, for a total word count of 10,000 words, the introduction should be at most 2,000 words, and each of the other two around 4,000 words.

If you're submitting your dissertation as a single piece of work, and not in separate submissions, you may find it easier not to write it in order.

It is often easier to start with the literature review **and then write the** methodology**.**

The introduction may be the last part you write, or you may wish to rewrite it once you've finished to reflect the flow of your arguments as they developed.

Writing Style

Dissertations and academic articles used always to be written in the third person, and in the passive voice; as an example, you might write 'An experiment was carried out to test…'

However, many journals have now moved away from that convention and request first person and active voice, which would require you to write 'I carried out an experiment to test…'

Check with your university about their requirements before you start to write.

If you cannot find any guidelines, then ask your supervisor and/or the person who will be marking your thesis about their preferences. Make sure that the voice and person are consistent throughout.

Whatever style is preferred, aim to keep your language simple and jargon-free. Use shorter, simpler words and phrases wherever possible. Short sentences are good as they are easier to follow. Any sentence that runs to more than three lines needs to be cut down or split.

Researching and Writing a Literature Review

A literature review demonstrates that you have read around your topic and have a broad understanding of previous research, including its limitations.

In the literature review, you summarise the main viewpoints and important facts that you encountered in your reading *as they relate to your chosen topic*. You will also use the literature review to justify the value of doing research on your topic by showing what is already known, what is not yet known, and how it is relevant.

Your literature review should not simply be descriptive but should also provide a critical analysis of the body of work, and demonstrate that you understand how it fits together as a whole and how your own research fits with previous studies.

A key aspect of a literature review is what sources you select to include, and which you exclude.

Finding Sources

Thanks to the internet, literature searches are now relatively easy, and can be done from the comfort of your own laptop without needing to go anywhere near a library.

However, a word of warning is in order here. The ease with which anybody can access and publish to the internet means that many items published online have not been scrutinised by anybody other than the author.

In other words, content has not necessarily been checked, you have no way of knowing whether the author's facts and claims are at all accurate and you could easily land yourself in trouble by blindly following or citing from online sources.

Furthermore, because items on the internet are frequently changed, you may find that something you read yesterday is no longer available in the same form today. However, internet sources can be very useful for up-to-date information, especially current affairs or ongoing or very recent research.

Blogs and sites like the encyclopaedia Wikipedia are particularly prone to these problems. For these reasons, a general rule of thumb is that you should only rely on internet resources from the websites of organisations whose information you already know to be reputable, like SkillsYouNeed.

Do not underestimate how much physical libraries and librarians may be able to help you.

Librarians are usually hugely experienced in using all the search tools and databases, and can often show you much quicker ways of doing things, as well as tips and tricks to help you refine your search.

Furthermore, libraries may have copies of books and academic journals that are not available online. So a trip to your library may prove to be very helpful.

Your search terms are one of the most important elements of finding the right sources for your research project and developing them is an ongoing process.

It's a good idea to start with a phrase that you think others will have used about the topic, perhaps that you have identified from your lectures and/or earlier study. You will probably find that your first few searches don't turn up much that's useful.

Use the one or two articles that you find that are on the right lines to identify alternative search terms, and continue to search until you turn up useful articles.

You can also use a tool such as Google Adword Keyword Research Tool to identify phrases and keywords that are similar to your chosen term(s). This tool is usually used by internet marketing professionals to help them find keywords similar to their own but can be useful for academic research too.

If you're really struggling to find articles on the right topic, but you're certain that they must be out there, drop your supervisor a note asking about possible search terms. Tell them what you've already used, and ask them for a few alternatives to get you started. However, this should be a last resort, as you don't want to demonstrate your ignorance too obviously!

Finally, keep searching. You need to read a lot of sources to find the most relevant and will probably end up discarding more than half of what you read. Use abstracts to decide which articles are worth reading, and don't read those that aren't relevant: keep checking back to your research questions and decide whether each article is useful. If not, move on.

How Many Sources?

Your university or college supervisor will be able to give you an idea of how many sources you should include in your literature review.

You will probably need to read at least double that number to find enough that are suitable for inclusion. You should also try to find several different sorts of sources: books, journal articles, dissertations, conference papers, working papers, and so on.

You need to make sure that you identify the key texts for the subject. Check a few references, and see which texts are cited most often, or ask the librarians how to use the databases to check how often each article is cited. A good way to identify when you have read enough is if your reading keeps turning up the same points and you're not learning anything new.

A Note on Dates

There are some theories or articles which are so important in a particular field that they need to be cited, however long ago they were originally published. But those apart, you should generally prefer more recent sources published in the last five or ten years. As a rough guide, the balance of publication dates should be about two thirds from the last 10 years, and no more than one third older than that.

In general, your literature review should start with one or two broad paragraphs, demonstrating your understanding of the breadth of your area of study.

You should then discuss the literature that deals with your area of research and, finally, consider and critique the studies that are most directly relevant.

You should spend most time on the latter.

Writing your literature review should be an iterative process.

The best way to do it is probably to summarise each source as you go along, referencing it carefully, and grouping your sources by themes.

You will almost certainly find that the themes develop as you go along, and so do your search terms. Use headings to store your summaries and then write a more polished section under that heading when you have enough sources to be able to 'compare and contrast' opposing views, and particularly to draw out areas where there is disagreement and/or conflicting evidence as these are the most fruitful for further research.

Where there are gaps, you can then go back and search for more sources on that area. The best literature reviews are not only descriptive, but draw together similar thinking and provide a critical analysis of the previous research, including highlighting really good studies, or identifying flaws and gaps.

Checklist of Questions for Critical Reading

Ask yourself the following questions to decide whether or not a particular piece of work is worth including in your literature review.

The Author

- Who is the author? What can I find out about him/her? Has he/she written other books, articles etc.?
- What is the author's position in the research process, e.g., gender, class, politics, life experience, relationship to research participants?

The Medium

- Where and when was the document produced? What type of document is it?
- Is it reporting original research that the author has done, or is it presenting second-hand information about a topic?
- Is it formal or informal?
- Is it 'authoritative' (e.g., academic, scientific) or 'popular' (newspaper or magazine article)?
- How has it been produced? Is it glossy, with lots of pictures, diagrams, etc.?
- If it is contained on a website, is the website from a reputable organisation, or is the document drawn from some other reputable source?

The Message

- What is being said?
- What is not being said?
- How is the argument presented? Why?
- What use has been made of diagrams, pictures etc.?
- Who was or is the intended audience?
- Whose interests are being served by this message? Are there political implications, for instance?
- What evidence is presented to support the claims that are made?
- Does the evidence actually support the claims? Is the evidence presented in enough detail for you to make up your own mind whether you agree with the claims?
- Are there errors or inconsistencies?
- What is the significance to my topic and the research that I wish to carry out?
- **Your literature review should also demonstrate how your study does or will relate to previous work, and how it either fills gaps, or responds to calls for further work.**
- **Your literature review will help you to refine your research question. It should also help you to explain how your methodology fits with previous work, and help you to identify and evaluate possible research methods.**
- A Note on Tense
- **When you are describing someone's findings or opinions, it is probably best to use the past tense.**

The Introduction

The introduction to your dissertation or thesis may well be the last part that you complete, excepting perhaps the abstract. However, it should not be the last part that you think about.

You should write a draft of your introduction very early on, perhaps as early as when you submit your research proposal, to set out a broad outline of your ideas, why you want to study this area, and what you hope to explore and/or establish.

You can, and should, update your introduction several times as your ideas develop. Keeping the introduction in mind will help you to ensure that your research stays on track.

The introduction provides the rationale for your dissertation, thesis or other research project: what you are trying to answer and why it is important to do this research.

Your introduction should contain a clear statement of the research question and the aims of the research (closely related to the question).

It should also introduce and briefly review the literature on your topic to show what is already known and explain the theoretical framework. If there are theoretical debates in the literature, then the introduction is a good place for the researcher to give his or her own perspective in conjunction with the **literature review** section of the dissertation.

The introduction should also indicate how your piece of research will contribute to the theoretical understanding of the topic.

Drawing on your Research Proposal

The introduction to your dissertation or thesis will probably draw heavily on your research proposal.

At the end of the introduction, it is also usual to set out an outline of the rest of the dissertation.

This can be as simple as '*Chapter 2 discusses my chosen methodology, Chapter 3 sets out my results, and Chapter 4 discusses the results and draws conclusions*'.

However, if your thesis is ordered by themes, then a more complex outline may be necessary.

Drafting and Redrafting

As with any other piece of writing, redrafting and editing will improve your text.

This is especially important for the introduction because it needs to hold your reader's attention and lead them into your research.

The best way to ensure that you can do this is to give yourself enough time to write a really good introduction, including several redrafts.

Do not view the introduction as a last minute job.

Methodology

A key part of your dissertation or thesis is the methodology. This is not quite the same as 'methods'.

The methodology describes the broad philosophical underpinning to your chosen research methods, including whether you are using qualitative or quantitative methods, or a mixture of both, and why.

You should be clear about the academic basis for all the choices of research methods that you have made. '*I was interested*' or '*I thought...*' is not enough; there must be good academic reasons for your choice.

What to Include in your Methodology

If you are submitting your dissertation in sections, with the methodology submitted before you actually undertake the research, you should use this section to set out exactly what you plan to do.

The methodology should be linked back to the literature to explain why you are using certain methods, and the academic basis of your choice.

If you are submitting as a single thesis, then the Methodology should explain what you did, with any refinements that you made as your work progressed. Again, it should have a clear academic justification of all the choices that you made and be linked back to the literature.

Common Research Methods for the Social Sciences

There are numerous research methods that can be used when researching scientific subjects, you should discuss which are the most appropriate for your research with your supervisor.

The following research methods are commonly used in social science, involving human subjects:

Interviews

One of the most flexible and widely used methods for gaining qualitative information about people's experiences, views and feelings is the interview.

An interview can be thought of as a guided conversation between a researcher (you) and somebody from whom you wish to learn something (often referred to as the 'informant').

The level of structure in an interview can vary, but most commonly interviewers follow a *semi-structured* format. This means that the interviewer will develop a guide to the topics that he or she wishes to cover in the conversation, and may even write out a number of questions to ask.

However, the interviewer is free to follow different paths of conversation that emerge over the course of the interview, or to prompt the informant to clarify and expand on certain points. Therefore, interviews are particularly good tools for gaining detailed information where the research question is open-ended in terms of the range of possible answers.

Interviews are not particularly well suited for gaining information from large numbers of people. Interviews are time-consuming, and so careful attention needs to be given to selecting informants who will have the knowledge or experiences necessary to answer the research question.

Observations

If a researcher wants to know *what* people do under certain circumstances, the most straightforward way to get this information is sometimes simply to watch them under those circumstances.

Observations can form a part of either quantitative or qualitative research. For instance, if a researcher wants to determine whether the introduction of a traffic sign makes any difference to the number of cars slowing down at a dangerous curve, she or he could sit near the curve and count the number of cars that do and do not slow down. Because the data will be *numbers* of cars, this is an example of quantitative observation.

A researcher wanting to know how people react to a billboard advertisement might spend time watching and describing the reactions of the people. In this case, the data would be *descriptive*, and would therefore be qualitative.

There are a number of potential ethical concerns that can arise with an observation study. Do the people being studied know that they are under observation? Can they give their consent? If some people are unhappy with being observed, is it possible to 'remove' them from the study while still carrying out observations of the others around them?

Questionnaires

If your intended research question requires you to collect standardised (and therefore comparable) information from a number of people, then questionnaires may be the best method to use.

Questionnaires can be used to collect both quantitative and qualitative data, although you will not be able to get the level of detail in qualitative responses to a questionnaire that you could in an interview.

Questionnaires require a great deal of care in their design and delivery, but a well-developed questionnaire can be distributed to a much larger number of people than it would be possible to interview.

Questionnaires are particularly well suited for research seeking to measure some parameters for a group of people (e.g., average age, percentage agreeing with a proposition, level of awareness of an issue), or to make comparisons between groups of people (e.g., to determine whether members of different generations held the same or different views on immigration).

Documentary Analysis

Documentary analysis involves obtaining data from existing documents without having to question people through interview, questionnaires or observe their behaviour. Documentary analysis is the main way that historians obtain data about their research subjects, but it can also be a valuable tool for contemporary social scientists.

Documents are tangible materials in which facts or ideas have been recorded. Typically, we think of items written or produced on paper, such as newspaper articles, Government policy records, leaflets and minutes of meetings. Items in other media can also be the subject of documentary analysis, including films, songs, websites and photographs.

Documents can reveal a great deal about the people or organisation that produced them and the social context in which they emerged.

Some documents are part of the public domain and are freely accessible, whereas other documents may be classified, confidential or otherwise unavailable to public access. If such documents are used as data for research, the researcher must come to an agreement with the holder of the documents about how the contents can and cannot be used and how confidentiality will be preserved.

How to Choose your Methodology and Precise Research Methods

Your methodology should be linked back to your research questions and previous research.

Visit your university or college library and ask the librarians for help; they should be able to help you to identify the standard research method textbooks in your field. Such books will help you to identify your broad research philosophy, and then choose methods which relate to that. This section of your dissertation or thesis should set your research in the context of its theoretical underpinnings.

The methodology should also explain the weaknesses of your chosen approach and how you plan to avoid the worst pitfalls, perhaps by triangulating your data with other methods, or why you do not think the weakness is relevant.

Structuring your Methodology

It is usually helpful to start your section on methodology by setting out the conceptual framework in which you plan to operate with reference to the key texts on that approach.

You should be clear throughout about the strengths and weaknesses of your chosen approach and how you plan to address them. You should also note any issues of which to be aware, for example in sample selection or to make your findings more relevant.

You should then move on to discuss your research questions, and how you plan to address each of them.

This is the point at which to set out your chosen research methods, including their theoretical basis, and the literature supporting them. You should make clear whether you think the method is ‘tried and tested’ or much more experimental, and what kind of reliance you could place on the results. You will also need to discuss this again in the discussion section.

Your research may even aim to test the research methods, to see if they work in certain circumstances.

You should conclude by summarising your research methods, the underpinning approach, and what you see as the key challenges that you will face in your research. Again, these are the areas that you will want to revisit in your discussion.

Conclusion

Your methodology, and the precise methods that you choose to use in your research, are crucial to its success.

It is worth spending plenty of time on this section to ensure that you get it right. As always, draw on the resources available to you, for example by discussing your plans in detail with your supervisor who may be able to suggest whether your approach has significant flaws which you could address in some way.

Results and Discussion

When writing a dissertation or thesis, the results and discussion sections can be both the most interesting as well as the most challenging sections to write.

You may choose to write these sections separately, or combine them into a single chapter, depending on your university's guidelines and your own preferences.

There are advantages to both approaches.

Writing the results and discussion as separate sections allows you to focus first on what results you obtained and set out clearly what happened in your experiments and/or investigations without worrying about their implications.

This can focus your mind on what the results actually show and help you to sort them in your head.

However, many people find it easier to combine the results with their implications as the two are closely connected.

Check your university's requirements carefully before combining the results and discussions sections as some specify that they must be kept separate.

Results Section

The Results section should set out your key experimental results, including any statistical analysis and whether or not the results of these are significant.

You should cover any literature supporting your interpretation of significance. It does not have to include everything you did, particularly for a doctorate dissertation. However, for an undergraduate or master's thesis, you will probably find that you need to include most of your work.

You should write your results section in the past tense: you are describing what you have done in the past.

Warning!

Every result included MUST have a method set out in the methods section. Check back to make sure that you have included all the relevant methods.

Conversely, every method should also have some results given so, if you choose to exclude certain experiments from the results, make sure that you remove mention of the method as well.

If you are unsure whether to include certain results, go back to your research questions and decide whether the results are relevant to them. It doesn't matter whether they are supportive or not, it's about relevance. If they are relevant, you should include them.

Having decided what to include, next decide what order to use. You could choose chronological, which should follow the methods, or in order from most to least important in the answering of your research questions, or by research question and/or hypothesis.

You also need to consider how best to present your results: tables, figures, graphs, or text. Try to use a variety of different methods of presentation, and consider your reader: 20 pages of dense tables are hard to understand, as are five pages of graphs, but a single table and well-chosen graph that illustrate your overall findings will make things much clearer.

Make sure that each table and figure has a number and a title. Number tables and figures in separate lists, but consecutively by the order in which you mention them in the text. If you have more than about two or three, it's often helpful to provide lists of tables and figures alongside the table of contents at the start of your dissertation.

Make sure that you including information about the size and direction of any changes, including percentage change if appropriate. Statistical tests should include details of p values or confidence intervals and limits.

While you don’t need to include all your primary evidence in this section, you should as a matter of good practice make it available in an appendix, to which you should refer at the relevant point.

For example:

Details of all the interview participants can be found in Appendix A, with transcripts of each interview in Appendix B.

You will, almost inevitably, find that you need to include some slight discussion of your results during this section. This discussion should evaluate the quality of the results and their reliability, but not stray too far into discussion of how far your results support your hypothesis and/or answer your research questions, as that is for the discussion section.

Discussion Section

This section has four purposes, it should:

1. Interpret and explain your results
2. Answer your research question
3. Justify your approach
4. Critically evaluate your study

The discussion section therefore needs to review your findings in the context of the literature and the existing knowledge about the subject.

You also need to demonstrate that you understand the limitations of your research and the implications of your findings for policy and practice. This section should be written in the present tense.

The Discussion section needs to follow from your results and relate back to your literature review. Make sure that everything you discuss is covered in the results section.

Warning!

Some universities require a separate section on recommendations for policy and practice and/or for future research, while others allow you to include this in your discussion, so check the guidelines carefully.

Starting the Task

Most people are likely to write this section best by preparing an outline, setting out the broad thrust of the argument, and how your results support it.

Fleshing Out the Detail

Once you have your outline in front of you, you can start to map out how your results fit into the outline.

This will help you to see whether your results are over-focused in one area, which is why writing up your research as you go along can be a helpful process. For each theme or area, you should discuss how the results help to answer your research question, and whether the results are consistent with your expectations and the literature.

The Importance of Understanding Differences

If your results are controversial and/or unexpected, you should set them fully in context and explain why you think that you obtained them.

Your explanations may include issues such as a non-representative sample for convenience purposes, a response rate skewed towards those with a particular experience, or your own involvement as a participant for sociological research.

You do not need to be apologetic about these, because you made a choice about them, which you should have justified in the methodology section. However, you do need to evaluate your own results against others' findings, especially if they are different. A full understanding of the limitations of your research is part of a good discussion section.

Top Tip

At this stage, you may want to revisit your literature review, unless you submitted it as a separate submission earlier, and revise it to draw out those studies which have proven more relevant.

Conclude by summarising the implications of your findings in brief, and explain why they are important for researchers and in practice, and provide some suggestions for further work.

You may also wish to make some recommendations for practice. As before, this may be a separate section, or included in your discussion.

Conclusion

The results and discussion, including conclusion and recommendations, are probably the most substantial sections of your dissertation. Once completed, you can begin to relax slightly: you are on to the last stages of writing!

Conclusion and Other Sections

Once you have completed the main body of your dissertation or thesis, you then need to worry about drawing your conclusions, and the additional pages, such as whether to include a table of contents.

Your university may have guidelines but, otherwise, you will have to use your own judgement.

This page gives some advice about what is often included and why.

Writing your Conclusion

This section will need to have several elements, including:

- **A brief summary**, just a few paragraphs, of your key findings, related back to what you expected to see (essential);
- **The conclusions which you have drawn from your research** (essential);
- **Why your research is important** for researchers and practitioners (essential);
- **Recommendations for future research** (strongly recommended, verging on essential);
- **Recommendations for practitioners** (strongly recommended in management and business courses and some other areas, so check with your supervisor whether this will be expected); and
- **A final paragraph** rounding off your dissertation or thesis.

Your conclusion does not need to be very long; no more than five pages is usually sufficient, although detailed recommendations for practice may require more space.

Other Elements for Inclusion

Title Page

Your university will almost certainly have formal guidelines on the format for the title page, which may need to be submitted separately for blind marking purposes.

As a general rule, the title page should contain the title of the thesis or dissertation, your name, your course, your supervisor and the date of submission or completion.

Abstract

This is a one page summary of your dissertation or thesis, effectively an executive summary.

Not every university requires a formal abstract, especially for undergraduate or master's theses, so check carefully. If one is required, it may be either structured or unstructured.

A structured abstract has subheadings, which should follow the same format as your dissertation itself (usually Literature, Methods, Results and Discussion). There will probably also be a word limit for the abstract.

If an abstract is required, it may be published separately from your thesis, as a way of indexing it. It will therefore be assessed both as a part of your thesis, and as a stand-alone document that will tell other researchers whether your dissertation will be useful in their studies. It is generally best to write the abstract last, when you are sure of the thread of your argument, and the most important areas to highlight.

Table of Contents

You should include a table of contents, which should include all headings and subheadings.

It is probably best to use the standard software tools to create and update this automatically, as it leads to fewer problems later on. If you're not sure how to do this, use the Help function in the software, or Google it.

The time spent learning how to do it accurately will be more than saved later on when you don't have to update it manually.

Table of Figures

You only really need to include this if you have a lot of figures. As with your table of contents, it's best to use the tools available in the software to create this, so that it will update automatically even if you move a table or figure later.

Acknowledgements

This section is used to ensure that you do not inadvertently fall foul of any 'taking help' guidance.

Use it to thank:

- Anyone who provided you with information, or who gave you their time as part of your research, for example, interviewees, or those who returned questionnaires;

- Any person or body who has provided you with funding or financial support that has enabled you to carry out your research;
- Anyone who has helped you with the writing, including anyone who has read and commented on a draft such as your supervisor, a proof-reader or a language editor, whether paid or unpaid;
- Anyone to whom you are particularly grateful, like your spouse or family for tolerating your absence from family occasions for years during your studies.

Appendices

You should not use appendices as a general 'dumping ground' for stuff you found interesting, but couldn't manage to shoehorn in anywhere else, or which you wanted to include but couldn't within the word count.

Appendices should be used for relevant information only, such as copies of your questionnaires or interview outlines, letters asking people to participate or additional proofs.

You can be reasonably confident that nobody will read them in any detail, so don't bother to use an appendix to explain why your argument is correct. Anything that you want to be read should be included in the main body of your text.

Finishing Off...

Check, Check and Check Again

Every university's requirements are slightly different in terms of format, what sections need to be included and so on.

Make sure that you check what you have done against your university's guidelines and that it conforms **exactly**.

If in doubt, check with the administrative staff dealing with submissions or with your supervisor. You really do not want to be penalised for an error of formatting.

Finally…

Make sure that you put your dissertation together in a single document, and read it over as a whole before submitting it.

It is also a good idea to get somebody else to proofread your work to check for any mistakes that you may have missed.

Collating your dissertation may introduce errors of formatting or style, or you may notice duplication between chapters that you had previously missed.

Allow sufficient time for collating and final checks, and also for any formal binding required by the university, to avoid any last minute panics.

LIST OF USED LITERATURE

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2. Editorial Staff (2016-03-03). "Psychology's reproducibility problem". Nature. Retrieved 2018-04-03.

3. Editorial Staff (March 7, 2008). "Scientific Method: Relationships among Scientific Paradigms". Seed magazine. Retrieved 2007-09-12.

4. Richard Feynman begins his Lectures with the atomic hypothesis, as his most compact statement of all scientific knowledge: "If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations ..., what statement would contain the most information in the fewest words? I believe it is ... that all things are made up of atoms – little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another. ..." R.P. Feynman; R.B. Leighton; Matthew Sands(1963). The Feynman Lectures on Physics. 1. p. 1-2. ISBN 0-201-02116-1.

5.J.C. Maxwell (1878). Matter and Motion. D. Van Nostrand. p. 9. ISBN 0-486-66895-9. Physical science is that department of knowledge which relates to the order of nature, or, in other words, to the regular succession of events.

6.H.D. Young; R.A. Freedman (2004). University Physics with Modern Physics (11th ed.). Addison Wesley. p. 2. Physics is an experimental science. Physicists observe the phenomena of nature and try to find patterns and principles that relate these phenomena. These patterns are called physical theories or, when they are very well established and of broad use, physical laws or principles.

7. S. Holzner (2006). Physics for Dummies. Wiley. p. 7. ISBN 0-470-61841-8. Physics is the study of your world and the world and universe around you.

8. Note: The term 'universe' is defined as everything that physically exists: the entirety of space and time, all forms of matter, energy and momentum, and the physical laws and constants that govern them. However, the term 'universe' may also be used in slightly different contextual senses, denoting concepts such as the cosmos or the philosophical world.

9. Evidence exists that the earliest civilizations dating back to beyond 3000 BCE, such as the Sumerians, Ancient Egyptians, and the Indus Valley Civilization, all had a predictive knowledge and a very basic understanding of the motions of the Sun, Moon, and stars.

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