ETHICS

in
Science Education, Research and Governance

Edited by
Kambadur Muralidhar, Amit Ghosh, Ashok Kumar Singhvi

Authors

Bhavana Behal, Praveen Chaddah, Srinivasan Chandrasekaran,
Alok Gardia, Amit Ghosh, Rohini Madhusudan Godbole,
Munishwar Nath Gupta, Subhash Chandra Lakhotia, Sunil Mukhi,
Manohar Lal Munjal, Kambadur Muralidhar, Nandula Raghuram,
Tanusri Saha-Dasgupta, Shobhona Sharma,
Lingadahalli Subrahmanya Shashidhara, Ashok Kumar Singhvi,
Bittianda Kuttapa Thelma, Binod Kumar Tripathi

Indian National Science Academy
New Delhi, India
2019

Indian National Science Academy
Bahadurshah Zafar Marg
New Delhi 110012, India

Preface

Over the years, the style and practice of science has seen a considerable transformation. The pursuit of Science has moved from an individual's curiosity driven enquiry to an institutionalized system with a subject focus, centralized funding and cadre based career options. This change of structure, has led to competitions in both intellectual and personnel domains and these, in turn have led to an increase in unethical practices. To add to this, developments in biological and pharmaceutical sciences have also led to ethical dilemmas on the use of animals/humans as objects. New development like the artificial intelligence and, the machine learning and use of the internet add altogether new layers to the concerns on ethics.

Increasing number of students and their need for quality education have also resulted in several compromises in the manner in which the admissions to the institutions are made, the manner in which the education is imparted and also the manner in which the examination and evaluations are conducted. At each stage unethical practices abound. In research arena, there are issues of plagiarism, predatory journals, manufacture of data without experiment, ghost or guest authorship to issues of use of money as a surrogate for quality, have all led to erosion of values and ethical standards. Similar issues have arisen in Science Governance and in fair treatment and equal opportunity in respect of gender biases. Ethics, in the manner in which scientific information is shared with the stake holders needs much discussion. All such unethical practices are rooted in the simple desire for short cuts to success and the innate aspiration of the less meritorious to rise higher in one's profession. Truth, which is the goal of Science, stands totally compromised.

The conditions of unethical practices in India are of diverse origins. On the one hand there are cases of willful adoption of unethical practices and on the other hand there are cases of sheer ignorance whereby, for example, many assume that copying from a web source as legitimate. Money and official status also play a major role in such matters.

Indian National Science Academy has been seized of these issues for long and, has expressed opinions whenever serious aberrations in the conduct of a scientist have been observed. An inter-academy (Indian National Science Academy, National Academy of Science and Indian Academy of Science) panel also has been formed for this purpose.
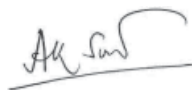
However, there is no consolidated documentation that would provide some guidelines to the uninitiated and inform an entrant about the contours and the nitty-gritty of ethical practices in the areas of Science Education, Research and Governance exists. An exception is the INSA treatise on animal ethics and several articles on various aspects of Ethics.

A group that included some members of Inter-Academy Panel, senior fellows of INSA and other invited experts including one from the media, met at INSA during June 16-17, 2018 and discussed various dimensions of Ethics and its practice in the broad domain of Science. The book is a result of their deliberations and is a collection of chapters ranging from education to measurement practice to plagiarism to outreach, gender-bias and governance. Each chapter has been prepared as a standalone summary which ipso-facto implies repetition on basic concepts at some places.

We hope that this book will initiate awareness in the scientific fraternity especially the younger colleagues, and ignite a debate in the community. We treat this version of the book as initial documentation and observations, and with time, we expect that the chapters will be refined further and enlarged to include other ethical issues including those associated with new technological developments. There is also a need to examine and report on legal aspects as well.

This book is a part of INSA's continuing effort to address various issues of contemporary interest in respect of Science and Societal well-being. INSA is in the process of bringing out a series of White Papers/Syntheses on such issues of societal relevance. These will by no means the final documents but, these will summarize the state of the understanding of scientific aspects at the current time and, provide science based evidences to inform policies. We expect these reports to evolve with time and create a long lasting baseline for national narrative in due course. Most of the work done for such books is by Fellows of the academies and is done on a voluntary basis.

I compliment the Editors for their sincere efforts to address to an important issue. This book was well coordinated by the Vice President Prof. AK Singhvi. I thank him personally for all his efforts in this endeavor. INSA will welcome feedback on any of the aspects so that these could be taken on board during the subsequent editions.

February 7, 2019   **AK Sood**
New Delhi   **President, INSA**

Acknowledgements

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Participants in the Workshop on Ethics in Science, Education, Research, Outreach and Governance

INSA June 16-17, 2018

Dr. VK Arora, Senior Consultant
Indian National Science Academy
Bahadur Shah Zafar Marg
New Delhi–110002
<esoffice@insa.nic.in>

Shri Pallava Bagla, Correspondent Science, Science Editor
New Delhi Television (NDTV)
33, Samachar Apartments, Mayur Vihar-I, New Delhi–110091
<pallava.bagla@gmail.com>

Prof. Praveen Chaddhah, Former Director
UGC-DAE Consortium for Scientific Research
Flat 702, Block 24, Heritage City, Gurugram–122002
<chaddah.praveen@gmail.com>

Prof. S Chandrasekaran, INSA Distinguished Professor
Dept. of Organic Chemistry, Indian Institute of Science
Bangalore–560012
E mail: scn@iisc.ac.in

Dr. Amit Ghosh, JC Bose Distinguished Professor, NASI
National Institute of Cholera & Enteric Diseases (ICMR)
JICA Building, P-33, CIT Scheme XM, Beliaghata, Kolkata–700010
<amitghosh24@yahoo.com>

Prof. MN Gupta, Former Emeritus Professor
Dept.of Biochemical Engg. and Biotechnology
Indian Institute of Technology, 508/Block 3, Kirti Apartments
Mayur Vihar Phase 1 Extension, Delhi–110091
<mn_gupta@hotmail.com>

Prof. Pratibha Jolly, Principal, Miranda House
University of Delhi, Delhi–110007
<pratibha.jolly@gmail.com>

Prof. SC Lakhotia, Distinguished Professor
Cytogenetics Lab, Department of Zoology
Banaras Hindu University, Varanasi–221005
<lakhotia@bhu.ac.in>

Dr. Alok Moitra, Adviser
Indian National Science Academy
Bahadur Shah Zafar Marg, New Delhi–110002
<alokmoitra@gmail.com>

Prof. Sunil Mukhi, Professor, Physics Program
Indian Institute of Science Education and Research (IISER)
Homi Bhabha Road, Pashan, Pune–411021
<sunil.mukhi@gmail.com>

Prof. ML Munjal, INSA Senior Scientist
Department of Mechanical Engineering
Indian Instittute of Science, Bengaluru–560012
<munjal@iisc.ac.in>

Prof. K Muralidhar, Former Jawahar Lal Nehru Chair
School of Life Sciences, University of Hyderabad
#303, Shobhanaadri Apartments, 7-1-69/1/25, Dharam Karan Road
Ameerpet, Hyderabad–500016
<kambadur2015@gmail.com>

Prof. N Raghu Ram
School of Biotechnology, GGS Indraprastha University
Sector 16C, Dwarka, New Delhi–110078
<raghuram98@hotmail.com>

Prof. AK Singhvi, Raja Ramanna Fellow
AMOPH Division, Physical Research Laboratory
Navarangpura, Ahmedabad–380054
<2aksprl11@gmail.com>

Prof. BK Thelma, Professor, Department of Genetics
University of Delhi, South Campus
Benito Juarez Road, New Delhi–110012
<thelmabk@.gmail.com>

Introduction

Kambadur Muralidhar

University of Hyderabad, Hyderabad, Telangana
#303, Shobhanaadri Apartments, 7-1-69/1/25, Dharam Karan Road
Ameerpet, Hyderabad–500016

> *"To be sure, it is impossible to prove the rightness of any ethical principles, or even to argue in its favour in just the manner in which we argue in favour of a scientific statement. Ethics is not a science. But although there is no 'rational scientific basis' of ethics, there is an ethical basis of science and of rationalism".*
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> *–Karl Popper*

This chapter traces the basic concept and philosophy of the modern science and how the need and concepts of Ethical Science arose and how these are becoming increasingly important. Stated simply, ethical conduct is a simple common sense that helps one to preserve the integrity of the individual, society and environment based on shared values. However due to pressures arising from the need and exigencies of survival in individuals and institution in societal and professional space, compromises in behaviors/actions that do not conform to anticipated fair play, do occur. In academics and research, often certain unethical practices occur due to sheer ignorance and lack of discourse. This book is the first step towards development of a comprehensive discourse on the broad theme of Ethics in Science, Research and Governance and we hope in due course of time and with the participation of all, this will be refined further

Origins of Modern Experimental Science

Experimental Natural Science arose in Europe as part of the Renaissance movement in the 15th Century CE. (Sarukkai, 2010). The philosophy of this science has been described by great minds like Francis Bacon, Rene Descartes, Thomas Kuhn, and Karl Popper, to mention a few. Through

the colonial rule, this science was introduced to India and to the rest of the world (Arnold, 2000, Raman, 2008). However, the basic curiosity to know the world around us, was part of human activity in every civilization. A brilliant example of this is to be found in the Persian scholar Al-Biruni's book on India Kitab *Tarikh Al–Hind*, (Al-Biruni, 1017). Philosophical traditions in every society probably grew after men and women organized themselves into settled societies after the discovery of agriculture, approximately 10000 years BCE, (Malinowski, 1955). An informal division of human activities / functions among the inhabitants existed. A small percentage of such human populations, (especially in ancient Greece, Persia, China and India) had accomplished thinkers like Thales, Pythagoras, Socrates, Plato, Democritus, Buddha, Mahavira, and Zarathustra. These however worked in a limited geographical region. In medieval South Asia, several thinkers wandered extensively and passed on their wisdom through poetry and music. This included for example the Sufis, Nayanars, and Alwars etc. and were known for their reflective thinking (Stokes, 2012).

The questions and problems these scholars addressed were either real time (i.e. materialistic about the Physical Nature of the world, its Environment and the human behavior) or supernatural aspects such as post-death future of mankind and the relationship between living and the dead (Russell, 1946, Durant, 1961, Smart, 1972). Great religions (i.e. the Abrahamic religions of Middle East, various versions of Hinduism etc.) arose out of the latter philosophical deliberations (Sen, 1991; Chattopadhyaya, 2015).

During the Renaissance movement, the focus was largely on the materialistic world. Among non-theistic philosophies, *Charvaka's* Materialism also figures (Hiriyanna, 1993; Swami Prabhavananda, 2009). This inquiry was named Natural Philosophy or more specifically Natural Sciences by the Masters during renaissance and was to be practiced by the use of scientific method of logic and deduction. The body of knowledge that resulted and the process of gaining that knowledge itself, together come to be known as Modern Science or Western Science.

In the modern sense, the formal definition of science came in 1831 through the British Association for Advancement of Science. It was a new philosophy constrained by both the phenomena that were inquired into and the methodology used for such an inquiry. Till the seventeenth century,

the sole aim of Science was to understand the structure and functioning of Nature and discover a set of laws and axioms that could explain the working of everything. These studies lead to discovery of Natural Laws which dictated and explained the behavior of Nature (Bhargava, 1995).

Francis Bacon and later Rene Descartes, the French mathematician and probably the first philosopher of science added one more aim, formally and emphatically. It was suggested that science should be useful to 'Man' in developing creature comforts, through control and exploitation of natural resources and phenomena, (Bernal, 1954). From then on, Fundamental science and Application oriented science (or even technology) became the twin Sciences. Natural science comprised three branches i.e. Physics, Chemistry and Biology. Each of these had the singular aim of knowing the 'TRUTH' about Nature akin to other systems of Philosophy (Lakoff and Johnson, 1998).

Science as a Culture and Philosophy

Every organized society has a set of myths or beliefs that are carried as narratives and mythological stories (carried by bards- the professional story tellers) and these give rise to customs, traditions and rituals. These together are called 'Culture'. While *'mythos'* gives rise to mythology, '*logos*' gives rise to Science (Thapar, 2002). Science gave another culture which was in conflict with the existing cultures all over. Further, in the 19th and 20th centuries, Science and Technology practically dictated the development plans for different Nations (Mohan Ram and Tandon, 2010) and this tradition continues till date. Increasing share of national budget earmarked for Science & Technology and related activities attracted a social auditing of this enterprise called Science (Viswanathan, 2018; Sarukkai, 2018; Mukhi, 2018). Society in general and sociologists in particular were in apparent conflict with Science as a Culture and as a Philosophy. The conflict was particularly acute in the perceived confrontation between Religion and Science and arose largely due to misunderstanding of the meaning and implications of both the true science and the true religion. This was despite the fact that both were pursuits of TRUTH.

Analysis of animal and plant groups indicate that conflict and cooperation is characteristic feature or all living entities, (Gadagkar, 1997). Conflicts in human societies have to be and can be resolved and assuming

adversarial positions do not lead to solutions. Informed discussions alone can lead to conflict resolution and hence are critical to the survival of the societies in question.

In the words of Vannevar Bush, one of the architects of American Science Policy, Science is 'amoral' i.e. Neither moral nor immoral. It is man who misuses Science & Technology and misinterprets science to general public and that aggravates this perceived conflict (Bronowski, 1965). The society needs to resolve this problem with native wisdom in a non-confrontational manner and with a process that seeks peace and harmony in society. Ancient Indian philosophical traditions (*vaada, prativaada and vidanda vaada*) and the Greek tradition of Plato have told us that debate and discussion across the table alone can solve problems and resolve contradictions. Intolerance and violence are not the means for conflict resolution A scientific culture takes recourse to evidence and logic as a key firmament for any conflict resolution.

Morals, Ethics and Laws

As per the Cambridge University Dictionary of English, the word Ethics implies, a system of accepted beliefs that control behavior, especially a system that is based on morals . The word Morality implies a set of personal or social standards for good or bad behavior and character or the quality of being right, honest, or acceptable. All 'civilized Nations' guarantee liberty, equality and individual freedom to their citizens. In our daily life and activities, each of us, occupy 'personal space' (otherwise called privacy) and 'public space' to varying degrees. Our behavior (i.e. conduct) and attitude, as individuals', is regulated by 'individual conscience' or a sense of morality. Morality is based on an individual's mindset and a basic human instinct (Hauser, 2007).

Studies of simpler animal groups like wasps, ants, tigers, elephants suggest a biological basis of morality and ethics. Humans carry a time-invariant sense of morality and ethics, and these are expressed explicitly, moderately, subtly or not even expressed to ensure social peace. There are neither incentives for following rules of morality nor punishments for going against conscience (Resnik, 2005). The Sanskrit word '*Swabhavika Dharma* 'comes closest to morality.

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With the passage of time, human societies and political nations evolved, and have clearly stated 'Laws' (oral/written) regulating expected social conduct in public space. These Laws are covered under a systematic 'Crime & Punishment' framework. The government of the land enforces these laws to regulate social behavior to establish social order. They are framed by legislatures and are subject to judicial scrutiny. Traffic rules, ownership of property rules, and tax rules are some examples. Laws need not always conform to morality. Some laws are abhorrent to some people when viewed from moral stand point. The word 'Nyaya' in our languages comes close to this Justice. *Dharma* and Justice need not always correlate with each other. *Dharma* is a Hindu, Buddhist and yogic concept that refers to the idea of a law or principle, governing the universe. For individuals to live out their respective dharma is for them to act in accordance with this law. More specifically, it implies human behaviors and ways of living that prevent society, family and nature from descending into chaos and these lead to the concepts of duty, rights, religion and morally appropriate behavior.

Considerable part of the society works in groups occupying public space. They belong to various professions. Engineers, physicians & surgeons, scientists, lawyers, traders and business persons, teachers, armed forces, and policemen are some examples. What dictates their social conduct within their professional group activities? The answer is in the understanding of professional ethics (The National Academy Press, 2009). Ethical conduct is usually spelt out as 'Best Practices'. They are mostly unwritten but followed in practice by all professionals. When violations exceeded the levels acceptable to the society, these desirable best practices were written down, not as laws, but as 'guidelines' to be followed in letter and spirit.

A majority of such guidelines have been evolved by professional societies and organizations (for example by the University Grants Commission, the Medical Council of India, the Veterinary Council of India or even the Academies in the Indian Context and by most academies and scientific bodies internationally). Unlike in the case of Laws, these ethical guidelines have no legal binding nor can be subjected to judicial scrutiny or intervention. These remain pious resolutions and remain contingent to the goodwill and conscience of the individual or the society.

Of course there are exceptions. Use of animals for experimental research and education is now strictly regulated by the guidelines of CPCSEA which includes punitive actions. Indian National Science Academy also developed consensus guidelines for use in research and education (Tandon, Muralidhar and Gupta, 2012). Ethical guidelines are as good as the sincerity in their practice.

Evolution of Social Ethics

As stated above, the idea of ethics in behavior is a human social construct. The biological basis of ethics can be traced to many animal groups (ants, wasps, tigers etc.) who exhibit eusociality - the highest level of organization of animal sociality defined by cooperative brood care (including care of offspring from other individuals), overlapping generations within a colony of adults, and a division of labor into reproductive and non-reproductive groups. Societal good takes precedence over individual benefit. In different periods of history, eminent sociologists and philosophers have written about and advocated expected social conduct from citizens (e.g. Manu's Smriti in Sanskrit, Thirukkural by Thiruvalluvar in Tamil, Koran by Mohammad, the great Prophet in Arabic, Confucius in China, Plato and Aristotle in Greece and Immanuel Kant and others in our more recent past etc. It is also to be admitted that there are no universally accepted ethical norms across different societies and across different situations within one society. Statements like 'everything is fair in love and war' or that 'ends do not justify means' have only added to the confusion in debates about ethics.

While *swabhavika dharma* should dictate human behavioral norms and judgments, Science, being an organized activity in search of 'TRUTH', has a mandatory set of norms. These are known as scientific temper and are written in the form of scientific methods, to be followed by every practicing scientist. In practice however, this is not followed by many. The reasons for deviant behavior are to be found in the way scientific activity is structured and conducted. First that the science is practiced in structured departments, centers, professional societies etc. and only occasionally by an individual in isolation. Second that Science, especially experimental science is carried out largely using public and private funds through projects. Third that, scientists receive various awards and recognitions

from their own scientific societies and also from society in general. Fourth, that the peer pressure adds another layer of major influence on scientists. Besides the pristine pursuit of science for knowledge, science is now a major career option for the middle class.

There are three major sectors which employ scientists in our country. These are the Universities, Ministry controlled research institutions and the strategic sectors of Defense, Atomic energy and the Space. In each of these, institutional goals and their realization depend on competence and aptitude of prospective employees i.e. the work force of scientists. When there is a mismatch between institutional goals and competence of employees, unethical practices creep in.

Such puzzling behavioral patterns are observed in all strata and activities of scientific establishments ranging from the award of Nobel Prizes (Friedman, 2001; Ramakrishnan, 2018), to the selection of teaching faculty, to the admission of students, to the funding of project proposals, to providing physical and material support to working scientists and, to the practice of institutional goals. The casualty in each of these is ethical conduct. Conflict arising from the need for institutional excellence on one hand and 'Scientific Truth' on the other hand probably gives rise to aberrant behavior.

Natural Scientists in general, Biologists more so, face another ethical dilemma. This pertains to the resolution of conflict of interests among scientists themselves. For biologists (Muralidhar, 2008), three particular cases are important and merit consideration here. The first issue deals with the conflict of interest between societies for animal rights, and ethics versus the demands of biomedical research and Animal Science Education. The second issue deals with the conflict of interest between philosophical underpinnings of Biodiversity Conservation and that of Bioprospecting i.e. Use of biodiversity derived products for human welfare. The third issue is the conflict between the environmentalists and Industrial/Technological development. Live and let live is the only answer to all these perplexing problems of existence and a very thin line between need, greed and propriety, exists.

Necessity for a 'Standalone' Document by INSA

Science and Technology have played a major role in transforming India from an underdeveloped country in 1947 to a reasonably developed country today (Shashidhara, 2017). As we continue in this path, we unfortunately also witness the continual presence of un-ethical practices in almost all walks of life with science and science education being no exceptions. These appear endemic to any developing system. At times in science research and education, unethical practices, could be due to partial penetration of scientific temper among practicing scientists and to insufficient and explicit exposure/discussion to what is ethical and moral. Science and its practices implicitly assume presence of scientific temper, rational thinking and evidence based logical conduct. This however is not found universally.

Though at the societal level, many institutions and individuals make efforts to educating layman about the irrationality of our 'mind sets' being the root cause of many social conflicts and tensions, myopic and sectarian considerations do overtake all other rational considerations. Science is no exception. Science Academies (e.g. INSA) and Professional Associations/ Societies of Domain Knowledge (e.g. SBCMB (I)) need to act towards rectifying such problems. A comprehensive 'standalone' book/document, however, does not exist in our national context.

To produce such a document that becomes the terra-firma of Ethical conduct in Science Education and Research, call for discussions among all stakeholders to generate a set of 'white papers' was made. Such white papers would then serve as source documents on 'expected social conduct' in the case of scientists, teachers, administrators of scientific establishments and educationists. The final step, of course, is how to make it a legal document which is binding on all working and teaching scientists. The present book is the first step in this direction.

Ethical Issues in Indian Science–A representative Note

In 1938, the physicist M.N. Saha requested Subhas Chandra Bose, the then President of the Congress, to set up a National Planning Committee in Science and Culture with Jawaharlal Nehru as its Chairman (Anderson, 2010, Habib, 2014). Over the last five decades, Science has grown

enormously in India. Prime Minister Pandit Jawaharlal Nehru saw a link between practice of quality science by its people and solutions to many of India's then existing social, economic, developmental problems. India continues to face these problems even now though to a lesser degree. The Government of India has identified the grand central challenges that India needs to cope with. These align with Sustainable Development Goals of the United Nations and include areas such as safe drinking water, nutrition and food security, eradication of poverty and hunger, ensuring public health and private hygiene, management of Natural resources, unemployment and underemployment among youth, ensuring fundamental rights enshrined in the Constitution including the right to education, resolving sectarian strife and ensuring energy security. Even a superficial analysis would suggest that Science and appropriate Technology are the only vehicles to resolve these issues.

Innovation and the use of innovation at the grass root level will be an essential ingredient to in all strategies and solutions to these vexing problems. The success of such a scientific enterprise of national dimension will cardinally depend on the ethical practices at all levels.

An important element that has not yet been fully realized is that empowering and skills development should not be restricted to instruction on skill sets but should integrate with them major instruction on character building. A good human being is the first requisite for Good Science. Ethical practices of research and education in science and in the generation, absorption and improvisation of Technology thus need to be deeply imbibed in the minds of the students.

Science today is an enterprise. It is an organized activity conducted in Institutions and by teams. When linked to rewards and recognitions, the competitive nature induces in some, unethical behavior for possible short term gains. Such aberrant behavioral patterns are discussed in subsequent chapters. As an institutional and group activity, science requires funding. In our country, government is the major source for funding. When funds become limited, competition increases, putting unhealthy pressure on scientists. In a country which is a little over hundred years old in the practice of modern science and technology, emphasis should be placed on originality and quality and not on quantity. Peer pressures tempt scientists to take short cuts. The highest ethics is in ethics of excellence. Creativity

does not survive in an atmosphere of selfishness. Quality assurance comes only through understanding of ethical dimensions. There is much room for improvement of competitive funding or examinations. Excellence and equity are mutually exclusive. Policy makers have to be clear in their minds about what they are looking for. Similarly all the activities connected with science like funding, doing research, education and training, must have an ethical foundation. Further, administering institutions should have ethical understanding of the task. Accountability of every player is the biggest ethical problem confronting us. The highest ethics is the ethics of excellence.

Organization of Funding for Science

Funding of arts and sciences has been an activity of all governments. In the modern era, Science & Technology have driven the national developmental programs and agenda. The distribution of state funds to deserving individuals and institutions needs to be carried out based on well-thought-out guidelines. These guidelines must be created through a thorough discussion among all the stake holders.

In the case of Physics and Chemistry which are highly conceptualized natural sciences, scientific merit and originality of the proposals mostly guide both the scientists and funding advisory committees in decision making process. Quality to some extent is assured. In Biology (Muralidhar, 2008), an old but persisting perception among Biologists is that it is an information driven science. However in recent years, some Biologists have been projecting Biology also as a highly conceptualized science. These two perceptions have to some extent resulted in funding policies being decided through sectarian battles (geographical as well as institutional) and not based on white papers on state of development of each domain of knowledge and National needs. In fact, sound and fool-proof criteria to judge the status of an area of research in terms of quality have not been yet developed and are difficult to develop (Madhan et. al. 2018). Scientometric analysis is only a surrogate marker of quality and has its philosophical issues (Stephan et.al. 2017). Honest and competent peer review has not been nurtured adequately in our country and reviews and decision are often more subjective than objective. The quality workers (globally recognized) do not have links with the average world of science (read Universities).

The latter hence, suffers in quality. Some issues such as the following, and probably many more, need to be addressed immediately.

1. Multiple funding for the same project/individual.
2. Decisions on thrust areas, vis-a-vis the National needs.
3. Relative weightage for Fundamental, Applied and Translational research areas including technology development and marketing vis-a-vis National needs.
4. Identifying future demands and manpower needs in fundamental and applied sciences.
5. Reducing regional inhomogeneity in skills/trainings.

Our country has many funding agencies differing in various degrees in criteria like transparency in operations, outcome of funded projects, identifying new areas, nurturing technology development and most important infra-structure building. Quality publications have not come out of all funded projects. Notwithstanding this, it is also true that Indian science, in terms of quality has not become an autonomous and sustainable activity. Breakthroughs are routinely coming from western science. Asia (excepting Japan) in general and India in particular have not contributed to discoveries and Inventions significantly.

Hence, the first question to ask while deciding on funding policy is-whether a vast size of third rate scientific manpower should be sustained or only technological achievements and sustainable first rate science should be supported. A prerequisite is commissioning of white papers on all aspects of Indian Science & Technology. An example is the one commissioned by INSA earlier (Shukla, 2005).

The Dilemmas of Research Ethics

Professor B.M. Hegde of NITTE University, defines Health as desire to do work. Wealth is then, indicated by desire to think. Possessing such health and wealth leads to happiness. Curiosity to know and understand drives pure research. A happy mind does research by instinct. Man is the only animal who can think and is aware of his/her thoughts. Science is a specialized thinking activity restricted to understanding structure and function of NATURE. It is constrained by research methods and research questions/problems only about Natural Phenomena. Research can be

done by individuals with freedom to think and decide. It is then an ideal activity. Pure Science is therefore value-free or 'amoral' i.e. neither moral nor immoral. Presently most research is carried out under institutional frameworks and as a group activity. Institutional goals and 'Careerism' then dictate the type of research work undertaken and takes away the freedom to think deeper and on the exotic and is called 'Professional Research'. Most scientists do not have the luxury of making a choice between 'ideal research' and 'professional research' and no new results can arise if one is not doing ideal, curiosity and aptitude driven science. This is the first research dilemma one faces. Ideal research or curiosity driven research activity follows identification of research problem/question that has a promise to unravel something new. True research problems arise in our minds from *ab initio*. In contrast, research problems for professional research, however, come from external sources i.e. published literature or assigned task etc. Professional research, done by experts, begins by identifying a time-bound research goal! It could be a 'technical program of work' executed in a reproducible pattern. Each area of research in 'domain knowledge' (e.g. Biochemistry, Cell Biology, Ecology etc.) has a 'pattern of technical problems' and 'characteristic techniques'. Professional researchers identify the 'research patterns' and execute them, but with technical rigor. Quality or standard is usually dictated and expected of that area by scientists from western countries. Professional research is application oriented research, has limited goals and does not usually lead to 'conceptual breakthroughs'. Most of the professional research work disappears from our memory within a generation! An ideal research activity is a contribution to domain knowledge and such scientists usually do not look for 'social recognition' or becoming 'popular scientists'.

Basic research, seeks 'peer review and acceptance'. A professional research activity, on the other hand, desires social recognition (awards, promotions etc.) from professional bodies (departments, academies and committees). Peer recognition of a conceptual breakthrough is permanent contribution to Knowledge and ends up as a page in the history. Awards and recognitions by committees may make the scientist famous and visible or even popular but, these live only for a short period of time. Thus Nobel Laureates go out of our combined memory but 'Nobel Class' work remains permanently etched in memory. These are great scientists and

their research work is great and represents highest quality. They are the 'geniuses' like Newton and Einstein.

Deciding on choice of research problem is the second research dilemma. A particular type of professional research, leading often to technology development or even an Invention remains permanent in our memory (E.g. diesel engine, electron microscope, DNA sequencing/finger printing, biofuels etc.), because they have enormous social impact at the level of the common man. It took Dr. Goldenberg in Brazil, decades of research to develop processes for ethanol production and he was generously funded. Today it accounts for a major portion of national income. Patentable knowledge results from such type of professional research work.

Decision making between Patenting and Publishing is the third research dilemma. Official government policies often influence decisions in such situations. There was a time when *Publish or Perish* was the *Mantra*. Then the *Mantra* of *Patent or Perish* took over. At present, a researchers are confused. Social recognition comes invariably, to such work and workers. Sometimes, however, peer recognition is denied to such workers! Even within the professional research groups, many scientists do not care for technical standards, characteristic of those research areas. Honesty and integrity of mind are essential for good work, not to speak of great work! The highest ethics is ethics of excellence, and striving for it (Mukhi, 2018).

Ethics of Education

Education is necessary ingredient to transform each of us into responsible citizens. In ancient India, it was understood as a process to raise an individual consciousness to its highest potential. In Sanskrit and other native Indian languages, the term used for it is *vidya*. Ancient India distinguished *paraa vidya* from *aparaa vidya* (Mookerji, 1989). The latter referred to skills which can be traded to earn a living.

Paraa Vidya was true higher education. The student had to seek his/her *Guru*/teacher *to* receive education. Ethics was part of instruction in both. British rule introduced University, College and School system of education. Even this had a component of moral education to make the students, law-abiding citizens in public life and with training to discern

between right or wrong in personal life. Independent India continued the colonial system with increasing separation of Natural Science from Humanities. Application oriented courses were separated as Professional courses (for example, Law, Medicine and Engineering etc.) leading to increased employability. Over a period of time, more and more information and some knowledge filled the curriculum. Two consequences of this process were apparent. One, the presentation of knowledge in fragments, euphemistically called specializations and second, ethics component of education became a casualty leading to considerable ignorance on basic tenets of Ethics in Education and Research

Experimental science seeks TRUTH just like Philosophy or Religion. In science, both the knowledge obtained and the means to obtain that knowledge are equally important. The latter is named as the Scientific Method. Measurement is the only experiment conducted in all Natural sciences. Criteria of reliability in terms of Precision, Accuracy, Sensitivity and Specificity are well defined. This is part of ethics in experimentation and training in these aspects is often suboptimal. At a broader canvass, transaction of knowledge in class rooms, field and laboratories, is based on the taxonomy of human knowledge during the given time period. These taxa are named departments, divisions, centers etc. and thereby define the boundaries of particular domain knowledge. It is accepted that the domain boundaries are becoming increasingly porous, the science becoming interdisciplinary and, in some cases, the subject classification have changed altogether.

Restructuring of University departments and UG-level and PG-level courses to reflect the true nature of the taxa is needed (Wilson, 1999). Taxonomy of human knowledge which directs establishment of departments is for convenience and is not time-invariant. Currently courses are named after the departmental name. Does it not become ethical, on the part of teachers, to demand and implement, syllabus revision and update and even restructuring of the courses and hence renaming of departments and centers? Opening new departments is not the answer. Reorganization and presentation of human knowledge is the need of the hour. This is the ethics of higher education which is conspicuous by its absence in our campuses (Karah, 2017). From a sociological and philosophical perspective, universities are losing their intellectual and ethical standards. Many

sociologists like Shiv Viswanathan, Sunder Sarukkai, have bemoaned this fact. But then INSA has no *locus standi* on this problem. More details will be found in chapters to follow.

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Ethics in Higher Education and Academic Research: A Conceptual Premise

Binod Kumar Tripathi

Inter-University Centre for Teacher Education, Banaras Hindu University, Varanasi, Uttar Pradesh–221005

Alok Gardia

Faculty of Education, Banaras Hindu University, Varanasi, Uttar Pradesh–221010

Bhavana Behal

Faculty of Education, Banaras Hindu University, Varanasi, Uttar Pradesh–221010

> *"We want that education by which character is formed, strength of mind is increased, the intellect is expanded, and by which one can stand on one's own feet".*
>
> *–Swami Vivekananda*

What is Education?

Education has been primarily associated with social and moral code of any society of the world. The influence of education on entire human society is undeniable; the present and future of any society in the world rests upon the kind of education being provided to its offspring. The National Policy on Education, 1986 enunciated that "No country can rise above the level of its teachers". Further, Kothari Commission also, in its famous remarks, put forward that the future of the country is being shaped in its classrooms. Therefore, it is of paramount importance to deal the issues of education with much seriousness so that growth and prosperity may go in proper norms and standards of human behavior. While defining education, Mahatma Gandhi said, 'by education I mean an all-around drawing out

best in child and man: body, mind and soul'. The objectives of education have been clearly spelled out here. Mere nurturing a mind full of cognitive abilities is not the only task of education. It also involves development of a harmonious personality which bears good moral character. Knowledge may be the biggest driving force in destroying the human civilization unless it is coalesced with right conduct and ethical human behavior. Sinha (1998), while elaborating the Gandhian thought and Vivekananda's perception, states that "Education should aim at balanced growth of the individual and insist on both knowledge and wisdom. It should train not only the intellect but bring grace and love in to the heart of man and wisdom is gained by constant assimilation of knowledge"

It is for this reason that a bridge between knowledge and skill need to be developed which should be that of value inculcation. At all levels of education, the focus on value inculcation should go hand in hand so that social and moral concerns may be addressed with each content and practice of education.

Ethics and Higher Education

It is in this context that the consideration of ethical aspect in education needs to be addressed. Very significantly, in the modern era, advocacy of quality education is going on, worldwide. Quality education is a dynamic concept. It evolves with time and is subject to social, economic and environmental conditions. Article 26 of the Universal Declaration of Human Rights (1948) – and the main treaties that guarantee the right to education – have defined the aims of education which impact on the content of education, teaching and learning processes and materials, the learning environment and learning outcomes. In such a domain, the quality is assessed in the sphere of quality of teaching and learning but parallel concerns on ethical issues is being addressed now to enhance the quality of education with proper orientation to ethics and values.

As a discipline, unlike morals, 'Ethics', deals with what is correct and what is wrong. For generations, cultures and societies across the world, established a moral code for social conduct for their members'. This code is to be adhered to and practiced at all times. Each cultural environment comprises certain institutions and forces which affect and shape the values, beliefs and behaviors of the society, (Kotler *et al.*, 2010). Beliefs may be

assumptions and convictions that are considered to be true by individuals, built up on the basis of real knowledge, opinion, or faith (Kotler *et al.*, 2010). We now live in the information age with a lot of scope of 'virtual' reality. Moreover, the current economic and social climate could also lead to unethical practices and behavior (Mann, 2012). Avoidance of such an occurrence makes it imperative that Ethics in Higher Education institutions, engaged in imparting higher learning to the younger generation (students) inculcate and instill in them, a value system which will teach them the importance of practicing ethics in learning and teaching.

According to Curko *et al.* (2015), the term ethics and value education (EVE) applies to all aspects of education which either explicitly or implicitly relate to ethical dimensions of life and are such that can be structured, regulated and monitored with appropriate educational methods and tools. Among the main aims of EVE are: to stimulate ethical reflection, awareness, responsibility, and compassion in children; provide children with insight into important ethical principles and values; equip them with intellectual capacities (critical thinking and evaluation, reflection, discovery, understanding, decision-making, non-cognitive abilities like compassion) for responsible moral judgment; to develop approaches to build a classroom or school environment as an ethical community, and to reflectively situate individuals into other local and global communities with a mission to contribute to the common good. All this enables pupils to overcome prejudice, discrimination, and other unethical practices and attitudes. Hence, there is a need to reinvigorate the education system to ensure that an effective and ideal citizenry is nurtured.

Ethics in Academic Research

The Radhakrishnan Commission (1948-49) highlighted the importance and the need to include spiritual training in the curriculum of educational institutions. The Mudaliar Commission (1952-53) stressed that student's character and the behavior would depend on religious and moral instruction. The Ramamurthy Committee (1990) reviewed that the essential quality of education is that, it must develop a set of values like love, compassion, social order based on truth and non-violence and integrating the science with spirituality.

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Considering the fact that students spend a significant part of their early and impressionable life with teachers who, contribute significantly into overall 'quality of student's lives'. There are numerous possibilities for teachers to influence the students to transform their persona in a good manner. They can analyze their life styles and behavioral attitude, by making them understand what is right and on decision on what students can commit for themselves and others. Through such instructions, teachers become architects of congenial societies. This can only happen if teachers themselves are aware of their responsibilities in shaping the moral and ethical values of student.

When discourse is in terms of ethics or moral aspects, we demarcate it with wrong and right, or desirable vs. unacceptable behavior. Ethics are the principles that allow us to uphold the things we value. David (2015) defines 'ethics' is the study which focuses on the disciplines that study standards of conduct, such as philosophy, theology, law, psychology, or sociology. One may also define ethics as a method, procedure, or perspective for deciding how to act and for analyzing complex problems and issues.

The learner imbibes ethical values from family, friends, fellow graduates, professional organization, mentors or other social settings. Although most people attain their perception of right and wrong during childhood, moral development materializes throughout life and human beings progress through different juncture of growth as they age. People acknowledge some common ethical norms but they infer, apply, and balance them in different ways in light of their own values and life experiences.

Issues in Research Ethics

Numerous institutions and organizations have a set of their code of ethics for their researchers; ethics itself is not a black and white subject. Perhaps, ethics is something that is inferred. Its understanding varies enormously from person to person. For this reason, there are controversies and disputes within the communities and society at large on certain issues.

For researches in humanities and social science, different kinds of ethical issues arise. New and evolving methods of conducting research, such as auto-ethnography and participatory action research raise important but strikingly different ethical issues and obligations for researchers.

New trend on researches on social media are coming up especially in the use of big data analytics. Participants here are from popular platforms of social media or forums based on the web. Respondents may post queries or respond in public place without comprehending that their conversation may be used for a critical research purpose without obtaining informed consent from them for the use of personal dialogues. At times, it may not even be feasible to acquire consent. Whether, ethics committees should permit such proposal for data analytics is a big unresolved, question. It is to be noted that big data research can lead to novel insight that may inform decision making and formulation of policies for new advancements in the society. On the contrary from the ethical viewpoint this creates a new challenge for the researchers.

Research encompassing vulnerable persons; include children, persons with developmental or cognitive disabilities, persons who are institutionalized, the homeless or those without legal status. These also raise unique issues in any research context.

Walton (2018) observed that in the contemporary era research, ethicists everywhere are dealing with issues that reflect Global concerns such as the conduct of research in developing countries, the ethical limits of research involving genetic material and the protection of privacy in light of advances in technology and internet capabilities.

Postulates for Maintaining Ethical Standards in Higher Education

Smith (2003) suggests that one of the best ways researchers can avoid and resolve ethical dilemmas is to know both what their ethical obligations are and what resources are available to them."Researchers can help themselves make ethical issues salient by reminding themselves of the basic underpinnings of research and professional ethics," as per Bullock and Smith (2003). Based on the forgoing, the following postulates are noteworthy:

Reliability and Integrity

Research project must be honest and diligent work of the scholar. This applies to the methods employed for the project (what you did), data

collection, analysis of results, and whether it has been previously published. One should not make up any data, including extrapolating unreasonably from some of their results, or do anything which could be construed as trying to mislead anyone. It is better to undersell than over-exaggerate your findings. When working with others, one should always keep to any agreements, and act sincerely.

Objectivity

One should focus to avoid bias in any aspect of their research, including design, data analysis, interpretation, and peer review. For example, researcher should never recommend as a peer reviewer someone he know, or who he has worked with, and he should try to ensure that no groups are inadvertently excluded from your research. This also means that there is a need to disclose any personal or financial interests that may affect the research proposal.

Genuineness

Researcher should always be prepared to share data and results, along with any new tools that have been developed, when he/she publishes his findings. This helps to further knowledge and advance science. One should also be open to the criticism and new ideas. Work must be reviewed carefully and critically to ensure that the results are credible. It becomes curial to keep full records of your research. If you are asked to act as a peer reviewer, you should take the time to do the job effectively and fully.

Respect for Intellectual Property

One should never plagiarize, or copy, other people's work and try to pass it off as their own. Scholars ought to seek permission before using other people's tools or methods, unpublished data or results. Not doing so is plagiarism. Obviously, one needs to respect copyrights and patents, together with other forms of intellectual property, and always acknowledge contributions to the present research. If in doubt, acknowledge, to circumvent any risk of charge of plagiarism. There is need to show respect for anything data/suggestion/idea that has been provided in confidence.

Caution should be taken to follow guidelines on protection of sensitive information such as patient records.

Novelty in Publication

Publication should be done to advance the state of research and knowledge, and not just to advance the career. This means, that one should not publish anything that is not new, or that duplicates someone else's work.

Protection of Subjects: Human/Animal

If research involves people, researcher should make sure that he/she minimizes any possible physical harm to the subject, and maximizes the benefits both to participants and other people.

Thus, the researcher should not expose people to more tests than are strictly necessary to fulfill the research aims. One should always respect human/animal rights, including the right to privacy and autonomy. For Humans, the researcher may need to take particular care in the case of vulnerable groups, which include, but are not limited to, children, older people, and those with learning difficulties. Sometimes, researchers may need to take special care in the manner in which they ask individuals to participate in their research, when dealing with a sensitive and fragile segment of group and are seeking personal data.

Agreement for Consent

Researchers must consider whether respondents are competent to give consent and free to volunteer it. In the case of minor (anyone under the age of 18), the consent of parents/guardian must be secure and, if possible and appropriate, the children's assent should also be sought. According to the Indian constitution, children under 18 cannot provide consent as being minors; therefore their parents or legitimate guardians must give consent on their behalf. Children may volunteer their participation for the research project at ground level but this should be done only after due written consent. Audio clipping of conversation with respondent should only be recorded if prior consent is given by them and they fully understand the manner recording will be used. If the researcher plans to use the same setting of recording for the new experiment, he would again require a fresh

written consent of the participant giving him the detail description about new study. However, when recording from electronic mass media devices such as television and radio are deployed for the non-profit research, one need to ascertain if a prior consent of the produce/publisher is needed.

Confidentiality and Anonymity

Researchers, with authorization from the respondent about their personal details need to exercise due caution that this data in any form (textual, audio or video records) does not accidentally allow them to be accessible. Confidentiality needs to be maintained sensu-stricto, where researcher need to protect the identity of the participant ; Anonymity is when the scholar himself is not aware about the particulars of the people being involved in the process of research for example; web survey, questionnaire. If the names of individuals are traceable (for instance, by appealing them to undersign) the study will no longer be qualified as an anonymous study.

The Informed Consent Form is used to ascertain the participants that personal or identification information will be not disclosed and only gross outcomes will be print, or in some cases their assent is taken to identify them with some specific traits (e.g. gender, organization).

Ethically, the respondents should be clearly informed what amount of their personal data will used and what could be the outcomes. The research ethics review process need to consider both the nature of the assurances given to participants and the steps taken by researchers to honors these commitments.

Concerns of Ethics for Teachers in the Academic Structure

The growth and development of youth is the teacher's responsibility. Though the key role of a teacher is to gather knowledge and disseminate the same to his/her students. For this, they need to create a congenial and amicable environment so that stipulated growth and development of the student occurs. The challenging task for the teacher is to accommodate the diversity of pupils as invariably they belong to a varied demography. Thus, it becomes obligatory for the teacher to recognize the desideratum of human growth and development. Such elements are the key indicator for a teacher to direct his effort towards making his / her students conforming

to professional competence with an ethical temper. Training to teachers has to be a continuing process so that the teachers are at the cutting edge of their profession and are updated on the contemporary narratives on ethical practices.

'The professional development of a teacher is achieved by exercising the ethical qualities in the specific professional practices of the educational task of teaching' (Sandoval & Rodríguez-Sedano, 2010).

Teachers are held in high esteem for their being synonymous with the ideal code of conduct. Implicitly therefore, a teacher's conduct serves as a catalyst for the change in the society. Under any circumstances, the personal lives of teacher and the conduct in the educational premises should not be at variance. They should provide ample scope for the holistic development of students. The fundamental duty of the teacher is to render their active role in the inculcation of character formation of their students. Sincere efforts are needed for the subjugation of personal interest to societal interest for common good. Further during evaluation process of biasness of any kind should be avoided.

Ceaseless endeavor is needed by the teachers to keep themselves on the cutting edge of their profession. Only then that they can enthuse the students on the nuances of science but inculcate in them the spirit of enquiry. Teachers who do not update themselves cease to attract students. Empathy remains the key to generate confidence in the students and then only a teacher can help students to deal with conflicts within and around. Core constitutional values and human dignity are to be suffused in the students by their mentors. Therefore personality traits of a teacher are compassion, secularism, democratic outlook, uprightness, euphony, and prudence, impeccable and critical analysis.

In pursuance of the recommendations of the National Policy on Education (1986, 1992), a Code of Professional Ethics for Teachers was jointly developed by the NCERT and the All India Federation of Primary and Secondary School Teacher's Organizations. The preamble to the code provides the resolve of the country's teachers to uphold their professional integrity, strive to enhance the dignity of the profession and to take suitable measures to curb professional misconduct. The professional obligations of a teacher relating to the following are included in the code:

1. Teacher in relation to the pupils,

2. Teacher in relation to parents and guardians,
3. Teacher in relation to the society and the nation,
4. Teacher in relation to profession, colleagues and professional organizations, and
5. Teacher in relation to the management and administration. Thirty principles related to these areas of a teacher's work serve as guidelines for the teachers' conduct. The primary source of these principles is the spirit of the constitution of our republic.

According to UGC report of the task force on code of professional ethics for university and college teachers (1988) whosoever adopts teaching as a profession assumes the obligation to conduct him-/her-self in accordance with the ideals of the profession. A teacher is constantly under the scrutiny of his students and the society at large. Therefore, every teacher should see that there is no incompatibility between his precepts and practice. The national ideals of education which have already been set forth and which he/she should seek to inculcate among students must be his/her own ideals. The profession further requires that the teachers should be calm, patient and communicative by temperament and amiable in disposition.

As alluded to elsewhere in the book, it is worth reiterating that the teacher should:

1. Adhere to a responsible pattern of conduct and demeanour expected of them by the community;
2. Manage their private affairs in a manner consistent with the dignity of the profession;
3. Seek to make professional growth continuous through study and research;
4. Express free and frank opinion by participation at professional meetings, seminars, conferences etc. towards the contribution of knowledge;
5. Maintain active membership of professional organizations and strive to improve education and profession through them;
6. Perform their duties in the form of teaching , tutorial, practical and seminar work conscientiously and with dedication;

7. Co-operate and assist in carrying out functions relating to the educational responsibilities of the college and the university such as: assisting in appraising applications for admission, advising and counselling students as well as assisting in the conduct of university and college examinations, including supervision, invigilation and evaluation; and

8. Participate in extension, co-curricular and extracurricular activities including community service.

Societal values change and seek constant changes/upgradation with time. After the mid-Nineties, economics and industrial goods and services became the fulcrum of development, memorizing facts and rules became the key to professions. In the present times of an economy, that is based on novel skills; brisk technological change; mass cultural adoption of technology; necessitate that the curriculum keeps pace with these trends. A continuing refinement in the curriculum alone can serve the needs of the society and it will be unethical, not to change it.

Another aspect that merits a conscious decision is the evaluation and prioritizing of measuring competence in understanding vs. score in examination in terms of clarity of concepts. A nation with more than a billion of assorted population cannot be evaluated only on a solitary number scale and numbers in a written examination can never be the yardstick for intelligence/competence. Skills such as, critical analysis, problem solving, communication, cooperation, digital literacy and creativity covering the whole occupation structure is now a mandate for 21st century. Today in the era of globalization, ample opportunities and privileges are available to the people with knowledge, skills, and capabilities to pursue their livelihoods. Educational institutes need to develop such curriculum which makes students internationally competent. And, changes in the curricula are continually required to ensure that the education system is able to achieve its set intent. Another facet for ethics is the attitude of the teachers towards changes in the curricula. Such changes pose a challenge before the teachers to keep themselves globally competitive.

Embracing advance curriculum demands allegiance and persistence from all the stakeholders. Teachers need to constantly develop new

pedagogies and kept abreast with 21st century skills and evaluations procedures and lead by example.

Conclusion

In the forgoing, different aspects of ethics in higher education have been discussed. It is inferred that the primary task of education is to mold future generations in competent human beings with high cognitive skills with a value system. Since, higher education is the forum that provides academic leadership to the country, it is imperative that ethical consideration should be placed high so that country attains appropriate ethical standards. Therefore, all personnel in higher education should be motivated and trained towards ethical dimensions of education as well. Research ethics needs careful nurturing. Besides laboratory research, ethical aspects of human behavior needs equal emphasis. These call for training of all in areas of humanities, history and social sciences. These will ensure that students and teachers get skilled to understand and appreciate the nuances and value of ethics in all dimensions.

Apart from research ethics there are several other ethical issues that need to be addressed specially in Indian higher education context. Such issues are discussed below and we follow Singh (2018).

Corruption: The major cause of ethical deterioration in education system is rapidly spreading corruption. Corruption in education can include, bribes and illegal fees for admission and examination; academic fraud, withholding teacher salaries or paying them at sub-par level, preferential promotion and placement, teacher absenteeism and illegal practices in the textbook preparation and procurement, meal provision and infrastructure.

Privatization of educational institutions is another major cause for the declining ethical values in education system. The private institutes are unable to produce a complete 'human capital' with ethical standards.

Teacher's absenteeism is another cause of concern. Teachers are the role models of students and in most rural communities, they are the most educated and respected personalities. Teacher absenteeism is one of the most serious causes of ethical declining of education.

Absence of value education in Curriculum: Value education is included in the primary education curriculum but at adult stages, which are the

most sensitive stages to build the character of the youth, the curriculum finds no space for value education.

Often the educator's pedagogy is not appropriate and contemporary. To add to this the manner of evaluation stresses on routine remembrance, the rote method. The accumulation or presentation of data is not enough to decide the criteria for quality education.

Guru (teacher) and *Shishya* (taught) bonding based on mutual trust has been compromised. The basic tenets of this tradition are that a student should learn to respect teacher and a teacher should selflessly teach his student do not exist in general.

In the present digital era, there is wide opportunity to make students aware of the moral values and ethical values. It is time appropriate to take necessary actions to explicitly inculcate moral and ethical values in their curriculum and have a practice of formal and informal discussions on daily routine in all aspects from personal to career.

The following suggestions can be implemented:

- Include moral and ethical values in the curriculum
- Provide value orientation in the curriculum.
- Demystify excessive focus on materialism and money.
- Teach innovatively
- Conduct programmes on values such as Personal Values, Social Values, Cultural Values, Spiritual Values, National values, Family values, Universal Values.
- Council students based on their individual persona.
- Develop community oriented activities and discuss social issues and their solutions.
- Moral science be introduced as a subject even at the higher education levels
- Teacher is provided appropriate respect by the society in terms of facilities and remuneration and in turn they should serve as inspirers and guiding person.
- Training in social conduct, inculcate the values in daily life, control of emotions, compassion leading to responsible, socially acceptable citizen be a part of curriculum

To achieve the above, a strong intervention is needed so that the entire system of higher education may also carry cultural, ethical components. Necessary pre-service and in-service intervention at university level may help. While preparing the students, mere focus to cognitive domain should be accompanied by balanced view of the value system. Gandhi advocated development of heart along with nurturing a mind that is full of cognitive abilities. A higher education system with such a wholesome template is the need.

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Chapter 3

Ethics of Research

Subhash Chandra Lakhotia

Cytogenetics Laboratory, Department of Zoology,
Banaras Hindu University, Varanasi–221005

Praveen Chaddah

2. Flat 702, Block 24, Heritage City, Gurgaon–122002

> *It is one of the many unique qualities of man, the new sort of animal, that he is the only ethical animal. The ethical need and its fulfillment are also products of evolution, but they have been produced in man alone"*
>
> *−G.G. Simpson (1949)*

Introduction

Man's ability to wonder, including wondering at his ability to wonder, is a unique feature of the human race. The ability of humans to transfer the new information and/or new interpretation of a phenomenon to other contemporary human beings and to those of future generations has been instrumental in progress of human civilizations.

Curiosity and the self-driven efforts to satisfy personal curiosity form the basis of research. Research involves systematic and creative investigations in any domain of knowledge, be it about philosophical or materialistic issues, or anything in this Universe that can be perceived by our senses. Such acts improve the understanding, enable postulation of operative laws and enhance knowledge. The improved knowledge in turn facilitates new conclusions and raises new questions. Being a social organism, it is natural that individuals, who acquired new knowledge/ understanding, share the same with others. This in turn implies that the society comprises both the owners and recipients of new information.

Research starts with questions for which a researcher wishes to seek answers. The researcher may be involved alone in this act of seeking answer, or may involve a group or groups with whom the researcher

collaborates. Since all institutions of higher learning are also bestowed with the responsibility of training young minds in the appropriate methods of research, a researcher also has the role of a mentor. Each of these aspects requires adherence to some basic ethical practices.

This chapter considers the ethical and general issues regarding the choice of the specific questions pertaining to research, principles of collaboration and roles of and relationship between mentors and mentees. For specific details on various issues, the guidelines provided by the Committee on Publication Ethics (COPE) may be referred to.

Topic of Research

Research is about creating new knowledge. It starts with defining the question for which one seeks an answer. However, to get a satisfactory and meaningful answer(s), researcher needs to have the required competence and capability to pursue the question effectively. The next requirement is the act of carrying out the actual research, which in the domain of science and may involve the use of theoretical and/or experimental approaches. The results with due interpretation and contextualization generate new knowledge/understanding. The final stage is dissemination of the outcome of research through sharing the new knowledge with others and its validation by other independent experts. At each of these steps Ethics related issues are involved. These are discussed below.

Ideally, one selects a question for further research because of the curiosity about some specific aspect where the researcher feels that the available information for a given phenomena/process/observation does not provide a satisfactory answer or explanation and/or provide an appropriate or optimal process/method. However, in reality the choice of specific topic selected for research is determined by a variety of factors such as the place of work and the research mandate of the institution/group. In other instances, like in universities and colleges, the researcher may have some more freedom in selection of the topic of research. Choice between basic or applied research in such places is left to the aptitude and the capability of the individual investigator. However, since most of research activity in academic institutions is public-funded, it may be desirable that some of the basic research also addresses issues of local relevance. Choice of a topic which cannot be addressed meaningfully in a given institutional

set up may lead to wasteful expenditure of public money and may thus be construed to be 'unethical'.

Researchers need to continuously update themselves in order to, keep their expertise contemporary and use the available facilities to enable them to move deeper into the research problem of their interest. The researcher may also initiate new areas with due diligence on understanding of previously acquired experiences. As the facilities and expertise improve with experience, research directions tend to evolve proportionately and at times may even lead to activities in altogether different direction(s). Such changes can be facilitated through collaborations with other researchers with complimentary expertise (see later). Failure to 'evolve' with time and experience is injustice to one's profession.

The most important determinant of the topic of research is the background training of the researcher. The question identified to be addressed must be commensurate with the experimental/theoretical capabilities of the investigator, and also with the accessible facilities. A research problem should not normally be selected by an investigator just because the field is 'hot' or more funding is available (Lakhotia, 2009). The researcher or his/her team should embark upon investigations in such 'hot' or better-funded areas only if they have the required interest and competence, for, doing otherwise is not being honest to the profession.

In recent decades, new techniques and technologies have been appearing at an exponentially faster pace. There is often a tendency to procure modern and 'latest' models of equipment or to create 'mega-facilities' without a defined question being addressed to. Many journals and reviewers also place undue importance on the use of 'latest' and 'high-end' techniques and equipment, which is also indirectly or directly promoted by industry. It is unethical to install or create a mega-facility with tax-payer's money only to 'show', while the actual utilization remains very limited. Further, the use of such a facility, without a valid reason, but only to 'impress' reviewers and readers, is also equally unethical. Researchers should not 'invent' questions to make use of the available 'fancy' facilities (Lakhotia, 2009). Rather, effort should be directed to create facilities that are relevant to the primary questions that are of interest to the researcher or use them where available on a collaborative basis. It must be noted that any instrumental facility not in use on a regular basis, morally constitutes an

unethical practice and it should be responsibility of the hosting institutions and the funding agencies to carry out rigorous audit and make use of such audit for future reference.

While formulating new research project proposal for funding support or for a graduate student, the time-frame, facilities and expertise available for completing the proposed work in the stipulated time-period need to be kept in mind. Young investigators, who are starting their academic career, should generally avoid taking up research projects that are near direct extensions of the work that was carried out by them during their doctoral and/or post-doctoral research. This would not only avoid a direct and unfavorable competition with the 'parent' lab but would also help the young investigator to establish one's own identity. Sensu-strcito, extension of ideas developed with supervisor, without his/her explicit consent also amounts to an unethical practice.

Research project to be taken up by an investigator should be original and not based on plagiarized idea(s) of others. Without due credits and permissions, it is grossly unethical to use unpublished ideas learnt as a reviewer or while listening to fellow workers explaining their research, for one's own research. The investigator has to ensure and satisfy for self that the methods and processes utilized for research are appropriate and correctly followed. In experimental research, 'good laboratory practices' need to be properly followed and documented. Appropriate clearances from institutional and/or national level ethics committees for the relevant domain must be obtained beforehand when undertaking research that may impinge upon various ethical issues (e.g. issues related to humans as subjects and samples derived from them, protection of privacy of human subjects, animal rights, environmental or habitat destructions etc. in bio-medical sciences or use of hazardous chemicals, radio-isotopes etc.).

Appropriate calibration and standardization of apparatuses/instruments and of materials used for research must be carried out so that the results remain reliable and reproducible by the investigators as well as by others.

Collaborative Research and Sharing of Credits

In recent times, research in sciences increasingly needs inter-disciplinary or trans-disciplinary approach. This requires collaboration of experts in

different but complementary domains so that the question being asked can be examined from different perspectives. In some cases collaboration develops at a late stage of investigation when help of another laboratory or researcher is required to fill in some gap/s for which the original lab is not so competent (Chaddah, 2018). Developing and maintaining healthy and productive collaboration requires good ethical practices. Such collaborations within the institution or outside should be forged on good and a priori well defined understanding to avoid possible conflicts at a later stage. A healthy and lasting collaboration is built on honesty and mutual trust for the long-term sustenance. Depending upon the need in specific cases, collaboration may be a one-time event or may be a long-term partnership. In either case, the bases of collaboration and credit-sharing should be understood and agreed upon at the initial stages itself as a safeguard against any later stage misunderstanding or dispute.

A collaborative work may also involve one or more Ph.D. student(s). In such cases, the basis for inclusion of specific aspects of the collaborative outcome in the doctoral thesis of the student/s should be understood and agreed upon ab-intio, by collaborating partners. This would ensure error-free data, avoid any accidental plagiarism and would make the dissemination of the research output smoother.

Collaboration may also be required in some cases when a research proposal is required to be submitted to make use of a centralized user facility (e.g., synchrotron radiation sources, neutron sources, particle accelerators, an inter-university Centre, a centralized or national computational facility or an instrumentation center) where use of the facility is allotted based on merit of the proposed work. The scientist responsible for use of the facility may become a collaborator in the specific investigation, even though the collaborator may not have been involved at the initial stages of the development of concept and the planning. It would be unethical plagiarism of ideas on part of the facility manager/provider to make use of the concept and/or design submitted by the original investigator without his/her knowledge/permission (Chaddah, 2018). Similarly it will be unethical on the part of user to take advantage of the facilities maintained by the hosts without assigning due credits. It is always advisable that the credit sharing be decided ab initio. In a large group, it may be appropriate to mention the contribution/s of each author. Claiming authorship by

virtue of being a group head/ institution head without any intellectual contribution is an unethical practice (for further discussion about ethical issues in authorship, see below and Chapter 5).

Mentoring Young Faculty

Mentoring young investigators (YI) and guiding Ph.D. research scholars is an important responsibility of senior scientists. Since ethical values are mostly transmitted and imbibed in an involuntary manner, the mentors have a great role in ensuring perpetuation of good ethical values and conduct. They need to lead by example and guide YI in developing and equipping their labs. A YI who joins a new place should be welcomed and facilitated to feel 'at home' by those already established there.

The YI needs advice about seeking financial support from appropriate agencies. While mentors need not hand-hold the YI, they may act as catalysts to help them find their own moorings. Mentors must not 'exploit' YI for their own glorification. If someone who had studied and/or worked for Ph.D. in a given department/institution and later joins the same place, he/she must be treated as a peer for an all-round healthy growth, rather than a student or subordinate, which may stunt the YI. From the YIs point of view, it will always be desirable to work in a place, other than where she/he obtained the doctorate degree. This is good for/her long term academic growth and will avoid complications arising from the conflict of interest.

Research Supervisor-Student Relationship

The relationship between a supervisor and Ph.D. scholar is markedly different from a typical teacher-student relationship. It requires a continuous dialogue so that the actual research work gets better synergized and the research student gets really involved in planning and execution of the plan, rather than working only as a technical help to the supervisor. Since the doctoral degree is generally the last step in formal learning, a good foundation in ethical practices is essential to prepare quality researchers who can be effective leaders in times to come. Some general practices that should be followed by the supervisor and students are noted below.

The research objectives and research plan that a new Ph.D. scholar wishes to undertake for his/her doctoral thesis should be adequately discussed by supervisor and student. For an informed and meaningful discussion leading to student's desire to work on the given topic, the student also needs to have read the relevant literature. A research student should choose the doctoral supervisor keeping in view his/her personal interests and competence in a given field and the research interests and competence of the proposed supervisor. A good matching of 'wavelengths' of the supervisor and student is essential for developing a healthy and lasting relationship.

The research plan should be discussed by both the student and the supervisor so that the research student understands why a given strategy is being followed as also the modus operandi on data collection, recording of observations and interpretations. Research supervisor should guide and steer progress of the student's research efforts so that the work to be embodied in the doctoral thesis can generally be completed within the stipulated time-frame available to the Ph.D. scholars. An overly ambitious plan with a large proportion of uncertainty should generally be avoided. However, if an enthusiastic student is willing to take the challenge, he/she may work on such questions with an explicit understanding that negative results can also be useful science. It must be realized at all level that more than anything else; a doctoral thesis is a training for a student to learn to carry out a project independently. This focus should never be lost.

Supervisor needs to ensure adequate training of research students on safe, ethical and appropriate usages of the various research methods and equipment. While they learn the technique, they should also be trained to understand their operative principles. Students should be encouraged to read widely, to participate in seminars and discussion meetings and to periodically present their own data and/or data from other publications to improve their ability to effectively communicate. They should be encouraged to share their ideas and it is the responsibility of the senior to create an ambience of trust.

Research students need to be encouraged and provided with opportunities to improve their writing skills (Moore, 2018). They should be encouraged to prepare the first drafts of manuscripts for publication or for the doctoral thesis. Any corrections/modifications made by the supervisor

should be explained to improve the learning curve of the young student. Supervisor must neither dogmatically impose his/her views on the research student nor expect the results to fit the supervisor's favored hypothesis. Student should be encouraged to have freedom to respectfully disagree with the supervisor if in the student's understanding; the supervisor's views appear to require modifications. A healthy discussion leads to better planning and, therefore, better outcome. Generally at this level, both students and the supervisor learn a new subject together and both should be matured enough to learn from each other through discussions.

Supervisors should also prepare and mentor the Ph.D. scholars as future independent researchers. This requires not only being good in asking relevant and original questions and designing appropriate research plans, but also understanding the process of research publications, research funding and general administration in laboratory so that younger colleagues learn to steer research from the very beginning. The doctoral thesis prepared by a Ph.D. scholar should include only the work actually carried out by him/her. When additional but closely related work, being simultaneously carried out in the lab or in other collaborator's lab, is required to be incorporated in the doctoral thesis for comprehensiveness, the same should be duly identified and acknowledged. The doctoral thesis is a candidate's lasting record of work carried out by him/her and for which the doctoral degree is conferred. Therefore, the work must be executed ethically and the same must be presented in the thesis following all the general ethical principles like refraining from plagiarism and manipulations of data and/or images.

The supervisor should ensure, using available text-similarity check software, that the document is free of plagiarism, including self-plagiarism. Its literary presentation should be good and due credits for earlier works should be provided as appropriate. Getting the doctoral thesis written by someone else on payment of a fee or for other considerations is grossly unethical as well as patently illegal. Likewise, it is totally illegal and unethical for the mentor to demand and receive unwarranted material gratifications from the Ph.D. scholar for supervision and 'getting the doctoral thesis ready'. Such practices should be reported and firmly dealt with.

Authorship in research publications emanating from the work embodied in a doctoral thesis follows the general ethical principles discussed above and in Chapter 5. The supervisor may decide to include or not include his/her name as an author depending upon how much was his/her actual contribution to the research work and the resulting manuscript. If for some reason(s), the supervisor does not wish to be named as an author, the Ph.D. scholar may be formally permitted to publish the work without the supervisor's name. However, it would be unethical for the supervisor to publish the work without the student's name. Any disagreement/dispute between supervisor and the Ph.D. scholar should be addressed timely so that it does not get blown out of proportion. Adequate institutional mechanisms, like the thesis advisory committee consisting of 3-4 faculties for each student, must exist to address all such issues.

Concluding Remarks

Research is the most important and fundamental activities of human society and has been singularly responsible for all the technological and economical advances that we enjoy. When carried out ethically it provides lasting pleasure and satisfaction to researcher also. Any short-cuts to achieve some pleasure/recognition in short-term may harm not only the researcher in more than one way in the long run, but also often have more lasting and wider implications in mis-directing efforts of other researchers with unwanted consequences. Therefore, effective training of enthusiastic young researchers in good ethical practices is as important as training them effectively in their chosen disciplines.

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Ethics in Measurement Practices

Munishwar Nath Gupta

Department of Biochemical Engineering and Biotechnology,
Indian Instittue of Technology, Hauz Khas, New Delhi–110016

Bittianda Kuttapa Thelma

Department of Genetics, Delhi University, South Campus,
Benito Juarez Road, New Delhi–110021

> *''The calamity of the information age is that the toxicity of data increases much faster than its benefits'*
>
> *– Nassim N Taleb in "The Bed of Procrustes", 2010*

Laboratory Record

Tom Clancy has written many best sellers. In more than one, these contain a line: "If you don't write it down, it never happened.'' (Clancy, 1995). A properly and neatly written laboratory record is important. David Baltimore became a Nobel Laureate at the age of 37. In late 1980's, he was involved in a controversy regarding one of his publications. The US secret service's forensic sciences division examined the lab records and found "evidence of sloppiness in the laboratory note books" of his collaborator. The above anecdote should convince us the relevance of maintenance of proper lab records in the context of ethical practices in science.

Complete Experimental Details are Important

One difficulty in reproducing published data is often because of missing experimental details. The importance of this is best illustrated from the need for STRENDA (standards for reporting enzyme data) checklist in the area of biochemistry (Cornish-Bowden and Kettner, 2014). Also, complete information leads to useful entries in standard data bases (Malhotra, Mukherjee and Gupta, 2013). Another origin of bad science is that in many labs the protocols are part of the 'wisdom imparted orally''.

A classic and relevant anecdote is about ''the most highly cited paper in publishing history'' (Kresege *et al.*, 2005). Lowry, for quite some time, did not publish his protocol for protein estimation. Among many beneficiaries of this orally imparted information was Earl Sutherland "who complained of being tired of referring to an unpublished method of Lowry'' and prompted Lowry to publish it. The advantage of putting something on paper (and trying to publish it) is that you are forced to look at your method more carefully. Lowry had to carry out 'a thorough study of the procedure' before the method was published. Rest, as they say is history! Barker's book (Barker, 2015) discusses extensively about the desirability of 'in house' protocols being available in the written form. In last few decades, a large number of protocol books have been published, at least in the broad area of life sciences. The seminal works, Methods in Enzymology, have served several generations of biochemists so well. Many of these published protocols emerge out of tried and tested 'in house' protocols. In the same context, it is part of good ethics not to discuss the results of a fellow lab mate with other people (especially outside the lab) without his/her consent (Barker, 2015). Given the facile communications via e-mail/WhatsApp, there is every danger that a hot result of the lab becomes prematurely known to a competing lab anywhere in the world. 'Loose lips sink ships'—they can also lead to your colleague/lab getting deprived of the credit.

Clarity in Writing

Day (Day, 1979) in his book, quotes Aaronsen (Aaronsen, 1977), 'the compulsion to include everything, leaving nothing out, does not prove that one has unlimited information; it proves that one lacks discrimination'. Obfuscation, even if unintentional, borders on being unethical. Contrary to popular belief, results section in a research paper is neither expected to be autobiographical nor is chronological account of one's time on the bench. It is expected to be a coherent and logical description of details.

Omission of number of replicates carried out corresponding to an observation is annoying; it also makes others unsure of the reliability of the data. Again, a quote from Day's book (Day, 1979) is a good example of how not to describe statistical details of your experiment, '33.3 % of the mice used in the experiment were cured by the test drug; 33.3% of the

test population were unaffected by the drug and remained in a moribund condition; the third mouse got away'. This is a clear example of misuse of statistical tools and over interpretation of data.

While how to write a scientific paper is not the theme of this chapter, the lack of clarity in presentation of research results is. Another gem from Day's book (Day, 1979) best illustrates the problem of bad language muddying possibly the results of what may have been good science, ''The left leg became numb at times and she walked it off. On her second day, the knee was better and on the third day it had completely disappeared''. Pronouns must clearly indicate which noun is being referred to. It is a fallacy to think that a single paper is expected to describe the discovery of an entire phenomenon in totality. This belief leads to over interpretation of the data. However, it is sometime equally important not to understate the importance of your work. The best example is from the famous paper describing the double helical structure of DNA (Watson and Crick, 1953). The authors debated about whether to say it and if so how to phrase it; what they wrote is master class stuff in paper writing, "It has not escaped our notice that specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material''. Moore (2000) has discussed the above paper to illustrate how presentation can possibly affect the impact of a paper. He does that by comparing the above paper with Avery's classical paper. For those not working in the area of molecular biology, Avery's work in 1944 identified DNA as the hereditary molecule. Avery's work did not win a Nobel Prize nor is it known outside the realm of biology. Moore (2000) quotes Nobel laureate Joshua Lederberg saying Avery's work was "the pivotal discovery of 20th century biology'' and "began the modern era of genetics''. The summary of Moore's conclusions as a case history may be instructive:

- Conciseness: Avery's paper had 7500 words long, the double helix paper had 900 words. Many journals publish communications only related to high impact work. As an example of verbose description, Moore mentions that USDA's directive for pricing cabbage had 15,629 words!

- The double helix paper had just enough details; more details were described in other papers by the authors. It was a smart decision to

split up the work in 3 publications. Avery's paper was too detailed especially in the conclusion section.
- Unlike the double helix paper, Avery's paper reflected his own doubts. Humility and objectivity are good traits in a scientist but self-doubts should be carefully expressed as analysis.
- Whether in a paper or a thesis; it is always a good idea to state objective clearly and as early as possible. The double helix paper did so in the first sentence, the word DNA occurs midway through Avery's paper.
- Emphasizing novelty: Avery's paper was presented as a 'more detailed analysis' of something previously known; the double helix paper had '…novel features of considerable biological interest'.

At the end of the day, it is up to the authors to convey context and importance of their work. On a personal note, one of us (MNG) got into biotechnology (Gupta and Mukherjee, 2015) because a peer reviewer was kind enough to express his exasperation - if you are isolating an enzyme from peanuts, how about telling us why you have chosen this source? How much peanut is grown in India? Sometimes, an unclear presentation of results can shut the door on many exciting possibilities as such kind peer reviewers are very rare!

Some Helpful Suggestions for Preparation of Manuscripts

One key legal as well as ethical issue involves copyrights. Some limited text can be reproduced as a quote with the source reference clearly identified (has been done in this write up). Any figure/table/video/infograph can only be cited after obtaining permission from the copyright holder. With the advent of open access journals, materials from these can be reproduced under common creative license but proper attribution is expected. So much is available in the public domain on the net but again ethically proper acknowledgements are desirable. Incidentally, self-plagiarism is also not ethical.

A frequent complaint from the referee is that the language is of not acceptable level. Following additional suggestions may be helpful.
- Day (1979) has listed 10 commandments of good writing. For those who want to write really well, a classic by Strunk Jr (1999) can be downloaded free from the net.

- Avoid jargon. Keep it simple and abbreviations [use only widely known ones, jargon must be defined when these appear for the first time in the text or as a separate list as per the style of the journal]. Same abbreviation is used for both singular and plural forms when writing units. We do not write 40 KDas; however without the numerical value, we should avoid abbreviation and write kilo Daltons.
- While writing references, stick to standard abbreviations for the name of the journals.
- Day (1979) has provided a list of common errors in spelling words commonly used in the areas of chemical and biochemical sciences. Such lists can be consulted when spellcheck comes up with weird suggestions.
- In recent years, Elsevier on its site provides a kit for authors which contains lots of very helpful advice.
- Don't ignore common sense. Avoid comparing apples with pears! Over the years, low reaction rates obtained with enzymes in low water media (Gupta, 1992) have been often compared with catalytic rates obtained with enzyme solutions in conventional medium i.e. aqueous buffers. This overlooks that enzymes in low water media act as heterogeneous catalysts, in aqueous buffers these are homogeneous catalysts. Secondly, these rates are often compared in the case of hydrolases. Hydrolases in aqueous buffers catalyze hydrolysis, in low water media (like nearly anhydrous organic solvents, ionic liquids and reverse micelles), these carry out the reverse reaction of synthesis.

Options in the Visual Display of Data (Tufte, 2001)

Both qualitative and quantitative information needs to be organized, analyzed and presented in a form so that both observations and inferences are easily grasped. With current technology, many new ways of describing a scientific work are emerging: GIF, MP4 videos and podcast etc. Here we will just list old well established basic ways as the new ways marry technology with these basic strategies.

- *Bar Charts:* normally describes discrete range or even qualitative picture.
- *Histogram:* it is a distribution of values among preset ranges of independent variable; ranges are arranged numerically. While

histograms in 3-D to include variations with respect to 2 or more independent variables had become fashionable for a while, lately these are frowned upon as gimmicky and obscuring parts of the data.

- *Scatter Plots:* used to show relationship between two variables, each datum point refers to a pair of corresponding value.
- *Pie Charts:* depicts a circle broken into sectors to show % range of values for each item.
- *Line Graph:* one of the commonest, different line graphs are often combined into a single figure to show variation with respect to another independent variable. A common mistake is not to clearly label different line graphs and not display error bars [if showed] properly.

Fidelity of Analysis

Our current enhanced capability of large data generation has added further complexity to the issue of making correct choices in terms of 'best fit'' models. Bremer and Doerge (2015) rightly observe that statistical analysis can be "perilous if these analyses are not done correctly'. They list some obvious but often overlooked pitfalls.

- Lack of clear objectives.
- Wrong data collected because of wrong choice of experimental design and/or tool.
- Enough replicates [see below for its formal definition] not carried out.
- Ignoring some parameters
- Using incorrect statistical approach.

Two examples at this point may be useful. Circular Dichroism (CD) of proteins is often carried out to analyze alpha-helical and beta sheet contents. Free software generally used are sometimes not appropriate but are routine used. Also, proteins rich in beta sheet often give erroneous values. Such results manage to get published because of poor quality of peer reviews.

Early publications of Zaks and Klibanov (1984, 1985) showed enzyme activity to be dependent on water concentration in the nearly anhydrous organic solvents. Subsequent work by Halling (1987) has clearly established that water activity instead is the correct independent variable.

Many workers just refer to the original papers to describe enzyme activity in organic media. Bremer and Doerge [2015] also make an important distinction between exploratory vs inferential statistics. A common mistake is exploring data without incorporating the experimental design. Zero variation among replicates should raise a red flag rather than attack of hubris. A good statistical model takes care of all source of variations among the replicates.

Ready availability of software for statistical analysis is a good example of providing dangerous tools to unskilled persons. In many publications, RSM is used without giving any improvement in the optimization process. To the uninitiated, response surface diagrams certainly look impressive.

Acceptable errors (from sampling or other experimental sources) are random. The appropriate choice of distribution is the one which allows us a measure of error and leads us to a value not affected by the errors. The best experimental designs involve prior defining of null hypothesis.

Some data require detailed statistical analysis; in other cases taking care of some simple rules may be enough. Before wading into deep waters, let us discuss some common mistakes, like, small samples but drawing more general conclusions, extrapolation / interpolation beyond the ranges of variables which have been investigated, ignoring effect of variables which are not studied. In social sciences and clinical studies, it is called ignoring ecological validity. Further, not giving estimates of uncertainty is also a mistake. Statistical methods do not eliminate uncertainty; these merely provide its estimates.

Let us briefly discuss some terms used in statistical analysis.

- Replicates, also called trials form the sample. If one takes 10 rats from 1000 under study, 10 is the sample size, 1000 is the population. If 10 aliquots are taken from a reaction and analyzed separately, 10 is the number of replicates. If an experiment as such is repeated 10 times, 10 is the number of replicates. Please note that concept of population does not apply in such cases.
- It is necessary that each replicate is independent of previous or future experiments/trials.
- The choice of each sample must be random.
- Paired data is better. An important example is inclusion of controls. Pairing enables better contrast.

- Spread is the dispersion around the mid-point; Standard deviation is a numerical estimate of the spread around mean.
- Median is the midpoint of the data. LD_{50} values, for example are median values.
- The square of standard deviation is Variance which also estimates the spread around the mean.
- Some distributions are commonly used to organize the data. One requires some experience to avoid wrong choice of the distribution.
- Normal distribution: Also called Gaussian distribution, it is a bell shaped frequency distribution which is symmetrical around mean.
- t-Distribution: It is a family of probability distributions, especially useful when sample size is small and standard deviation is unknown. Population has to follow normal distribution.
- Poisson distribution: It is also a probability distribution with frequency of occurrence as x-axis. Different distribution curves arise for different expected number of occurrences. The event occurrences must have a constant rate and each occurrence must be independent of others. Decay reactions per unit time is a well-known example of Poisson distribution. Poisson distribution is a special case of binomial distribution i.e. only two possibilities exist which can be described in terms of yes or no. In Poisson's, frequency of positive outcome is very low. Chi square distribution is the distribution of variance and looks like a skewed normal distribution.

Adams (2003) gives a good rule of thumb about normal distributions: "99% of the values fall within the 2.58 standard deviations of the mean" A common mistake is to use normal distribution even when it is not applicable. The famous Black Swan hypothesis of Taleb (2007) actually revolves around failure of normal distributions to correctly predict low probability phenomena [see later discussion]. Analysis of Variance [ANOVA] allows one to compare the effect of two conditions on the process. This becomes useful when different conditions influence each other. Once conditions which are important in influencing the outcome are identified; RSM (response surface methodology) can be used to identify optimum conditions. Neural network approach can also be used to optimize a process.

Precision, Accuracy and Errors

Jeffery *et al.* (1989) state that "accuracy expresses the correctness of a measurement and precision the reproducibility of a measurement. Precision always accompanies accuracy, but a high degree of precision does not imply accuracy." A good example is the increasing use of bio pipettes. These are not accurate but are precise. The good old glass pipettes are more accurate and also precise if correctly used!

Some errors can be minimized or estimated easily, these are called Systematic or Determinate errors. These include those originating from lack of skill, operational sources (loss due to incomplete transfer of material, for example), instruments and these reagents, wrong choice of method. Additive and proportional errors are also included in this list. Random or Indeterminate errors which are characterized by large errors being less frequent and positive and negative deviations occurring with nearly same frequency.

Significant Figures

While this is taught in courses in school mathematics, this concept bothers lot of people and this issue quite often attracts critical comments during the peer review. Often, unintended consequence is over interpretation of results. One of the simplest discussions of this can be found in a old and well known text (Jeffery *et al.*, 1979).

Thus, 1 to 9 are all significant figures, the digit 0 is also significant except when it is the first figure in a number. This is best understood by examples.

In 2.045, 0 is a significant figure; but in 0.045, 0 is not a significant figure. The rationale is that in the latter, 0 merely defines the position of decimal; 0.045 km can be written as 45 m. We say that number of significant figures, are only two in this case.

In 2.140 g, 0 is significant as it tells us that the weight is between 2.0400 and 2.1404. "The digits of a number which are needed to express the precision of the measurement from which the number was derived are known as significant figures". Please note that some authors differ and write that in a number like 2.140, 0 is not significant (Adams, 2003). While these different views about definition of significant figures may

be confusing; nobody can disagree with the rationale given by Jeffery (1979).

In all arithmetical operations, the result is expressed up to the significant figure in the least precise number.

Biases around Probability

Cognitive biases affect our estimating probability and hence our decision making. While the basis of scientific approach is objectivity, our view of what objectivity is gets colored by these cognitive biases. At the last count, more than 100 have been mentioned. We will briefly discuss more important ones. More discussion on these can be found at a number of places (Ariely, 2010; Dobelli, 2013; Kahneman, 2011; Taleb, 2007).

Ambiguity Effect

Described by Ellsberg in 1961, this states that "we tend to ignore options for which the probability of a favorable outcome is unknown'' (Butchering, Laricev and Merrick, 1990).Thus, we tend to avoid consideration of parameters about which we do not have enough information.

Confirmation Bias

Perhaps the most important one, it means we tend to favor the data which agrees with our hypothesis. Dobelli (2013) quotes Warren Buffet "What the human being is best at doing, is interpreting all new information so that their prior conclusions remain intact''!

While discussing the results, it is ethical to include even those references which oppose your hypothesis.

Zero-risk Bias

It relates to our having a better grasp of magnitude/amount/number as compared to probability of getting that number. Most of us are bad at estimating the magnitude of risk. We readily prefer what we think are zero risk options. Lot of good and challenging experiments are often not carried out as average scientists tend to practice 'safe science'. Options with zero risk are rare. According to Dobelli (2013), the US food act of

1958 prohibiting carcinogens has negative consequences. Industry has started using more harmful substances, even if non-carcinogenic.

Framing Effect

If you reduce the size of figures, more points fall on the line! This bias makes us favor data/arguments which are framed in better terms .A good ad succeeds, a bad one does not.

Hindsight Bias

This prevents us learning from a failed experiment. We make up reasons why we should have been wiser whereas the correct reason is likely to be that we did not have enough information at that point in time.

Serial Position Effect

Our brains are hardwired to pay more attention to initial and later points. Tragically, good data can go unnoticed if it appears in the middle. Same bias means people tend to read first and last few words of a title. Similarly, introduction and conclusion tend to become more important than your methods and results in deciding the fate of your manuscript.

Sunk Cost Fallacy

It makes us persist in lost causes. It also implies that we should be prepared to discard redundant data lest it obscures good data. Just because you made a bad choice in buying costly equipment(s) should not be the reason to design experiments which involve its use.

Herd Instinct/Authority Bias/Survivorship Bias

These are somewhat related though not identical biases. First refers to what has been called sheep mentality in plain English. So many people believe that enzymes are too costly to be used at industrial level. The fact is many enzymes, which are in fact called industrial enzymes are not only used in diverse industries, in many cases their cost is a small % of overall process cost. A bad outcome of this bias is that sometime a bad protocol but a well cited one continues to be followed.

Occasionally, when an Asian working abroad gets a recognition, there is generally an outcry about why people back home do not do so well/ or leave the country. Often, the conclusion is that culturally, Asians are supposed to have ingrained authority bias. For how many decades, the "instruction theory" to explain functioning of immune system survived? One of the reasons for its long life was that its main supporter was Linus Pauling. Brand ambassadors and advertising thrives on this kind of bias. Supported by twitter, some scientific findings became more acceptable. As Dobelli writes 'As a result, you will not read about the studies with the 'boring', but 'correct results'. Follow well cited protocols but do not easily reject own results if you fail to reproduce that protocol.

Fundamental Attributes of Error

What is the message when a sportsperson advertises a nutritional supplement? He/she has become a good sportsperson by taking those supplements or [more likely] is being paid to advertise that since he/she is a well-known sportsperson. More people use room heaters in winter; also more people drink coffee in winter. This does not mean that more coffee you drink, more likely you are to use a room heater. In scientific research, this bias becomes important while designing experiments as well as when interpreting results.

Contrast Effect Bias

Percentages can be deceptive. Ten % of 1000 is 100; 10% of 1 is merely 0.1. The latter change if observed may be just experimental error.

Availability Bias

Just because a particular protocol/reagent/tool is available more easily, it is not necessarily the best choice.

Story Bias

Many publications with bad science go through because authors have managed to spin a neat story around their science. Good peer review should see through it but that is not always there.

Overconfidence Effect

Statistical analyses do not eliminate error! They merely estimate it. Again, as Taleb (2007) discusses at length, low probability phenomena, in spite of soothing predictions of Gaussian curve, do occur. As Dobelli (2013) points out, it is a relative of strategic misrepresentation. When a salesperson tries to sell you a new instrument at a moderate price (as compared to competitors), look for hidden costs like cost of software or reagents required.

Base-rate Neglect & Regression to the Mean

It is helpful to discuss these together. Base-rate neglect means overlooking the probability factor. A chemical catalyst is unlikely to show rate enhancement of the order which is typical of enzymes. In detective fiction, it is called "butler did it". In other words, rule out the obvious while interpreting the data. Regression to mean refers to the fact that in many phenomena like weather fluctuations, stock market etc. values average out provided large samples are considered (and no black swan event occurs!). Overlooking this, we often tend to identify causes/parameters which in reality played no role. With other kind of phenomenon, like citation of a paper, there is no regression to mean. It is a chain effect. More important, independent events will result in regression to mean only if large samples are taken. A coin flipped 1000 times will adhere to the probability of 50% but 4 successive 'heads' should not be a cause for surprise.

Pattern recognitions require extreme skepticism. The events with finite probability, like small number of successive heads during coin flipping, can occur. Check the validity of pattern with large trials/samples. In experimental sciences, independent events are less common than interdependent events.

Safety

Ethical practices include following safety rules that are not just limited to your own safety but of your colleagues/labs as well. In India, we tend to be lax about this aspect. Many of our labs do not have two doors for exiting. Primary safety devices like safety goggles, a functional fuming cupboard, and a shower nearby, all are necessary at least near a lab where

chemicals are handled. It is a misconception that enzymes are safe; when handled in bulk; many proteins in general can hurt if not handled properly. American Chemical Society has published a booklet on safety (Pine, 1990), it is fairly extensive. Some sections like on guide to chemical hazards and waste disposal may be of relevance to research workers in other sectors as well. Institute of chemical engineers, UK occasionally runs a course called six pillars of safety. Surely, similar resources are available in other areas and should be consulted. One practice which is followed in some universities abroad is worth adopting universally. Every new lab member, irrespective of his/her status, has to sign a document that he/she has seen a document/video outlining safety rules.

Research Involving Animal Subjects

Laboratory based learning has been the most exciting aspect for most students, especially, of life sciences. A deep appreciation of, be it the digestive system, circulatory system, neural system or reproductive system, in the laboratory, has always emerged from dissection of suitable animals ranging from cockroaches to earthworms to rats or even cadavers in the case of medical education. Working with animals is also an integral part of higher echelons of scientific research. Almost all aspects of basic biological as well as biomedical research warrant use of suitable big or small animals, most often to be killed at the end of the experimental regimen. Awareness together with activism has transformed if not curbed the scale and nature of research involving animals. Some experiments such as studying chromosomes from the bone marrow or which involved killing the animals were completely abolished from the realm of teaching and research, others came under the scrutiny of regulatory bodies functioning within a framework of guidelines of do's and don'ts with experimental animals. This was the genesis of animal ethics committees in institutions of higher learning since the last two decades. INSA issued guidelines as early as 1990s. A detailed account and the legal framework within which research involving animals has been published in a book (Tandon, Muralidhar and Gupta, 2013). Of course, CPCSEA guide lines are always to be followed. Therefore, this topic will not be dealt with in this chapter but only salient features of guidelines for animal related research is summarized below.

Research on Human Samples

Human beings voluntarily or per force have been subjects for anthropological, sociological and medical research for the last four hundred years. From early beginnings of immunization to current carefully conducted clinical trials, human beings have served as excellent research subjects. Contrary to the eras of observational science and large part of experimental science, technological advancements in the last three decades have encouraged ethical considerations to be identified, notified and implemented for conducting research involving human subjects under life sciences as well as social sciences. One of the earliest references to science research involving human subjects and setting up guidelines was the Declaration of Helsinki (WHO, 2001). This was followed up by the setting up of Institutional Review Boards (IRB) at all public and private institutions across all countries proposing to conduct research on human subjects. Indian Council of Medical Research (ICMR), New Delhi also came with its first set of guidelines in 2000 followed by revised guidelines from time to time (http://bic.icmr.org.in/nacscrt/).

Need for Institutional Ethical Committees

With the advent of recombinant DNA technology in the mid-1970s, advances in immunological and other branches of biomedical research and successful completion of the Human Genome Project leading to large scale genome analysis studies, possibility of genetic manipulation and gene therapy, and so on, guidelines for including human study subjects, both affected individuals as well as healthy controls became a necessary evil. Protection of the rights of the individual, maintaining confidentiality of the participants, sharing information sheet and obtaining the consent of participants in the study were the main objectives. Ethical, legal and social issues popularly referred to as ELSI emerged as an integral part of biomedical research. Though the procedural steps have now evolved over time but the core features remain the same and these of these have been presented below.

Members of the Ethical Committee

Clear guidelines on the composition of the committee, their responsibilities and conflicts of interest are provided on the ICMR website (http://bic.icmr.org.in/nacscrt/) and on the websites of respective regulatory agencies.

Information Sheet for Study Participants

This document in English and local languages, provides a brief background on the subject of research, lacunae in the area encouraging such research, rationale for the said study, expected outcome, implications of the study, risks and benefits, if any, to the participants, right to withdraw from the study etc. Individuals with disease as well as those without, who essentially serve as healthy controls would be given in this document for their careful reading and understanding.

Informed Consent

Following project related information sharing with the prospective participants and providing assistance if needed, to clarify their doubts, if any, their consent is sought. For research involving newborns, minor subjects, mentally challenged individuals, or adults with mental illness, consent may be sought from parents or guardians. For illiterates, social workers may be sought to explain and assist.

Maintaining Confidentiality of the Participants

Details of participants and their personal/medical/clinical records would be treated with utmost confidentiality. Anonymization of the samples/details is the first step in the process. This starts with barcoding of the datasheet, the biological sample, be it saliva, body fluids, blood sample or tissue biopsy samples in the clinical laboratories of the respective hospitals.

Use of the Samples for Future Studies

Permission from the participants is sought a priori for utilization of the samples, if available, after the conduct of the experiments for related

future studies. If the participant refuses permission, the remaining samples leftover after the conduct of the specific study, may be destroyed.

When do you Seek Clearance?

Approval of the ethical committee should be sought firstly by the principal investigators at the hospital where the participant is being recruited; academic institutions and study centers have to then obtain the clearance from their respective institutions prior to initiation of the study. In most cases where projects are supported by grants from funding agencies, projects are to be sanctioned and money released only after the ethical committee clearance is submitted by the PI.

Conclusions

It may be worthwhile to end with some recommendations which may form the basis of code of conduct or suggestions to the policy makers. But then, framing lots of new rules has never prevented people from being unethical in any sphere. What we can hope for is to spread awareness about what is not ethical. Given how technology also helps create a flash mob, we should also send out message that to make unsubstantiated accusation is also unethical. One miscarriage of justice puts us back considerably in creating a just society. It is also necessary to define grades of unethical behavior. Repeated unethical behavior should be taken more seriously.

Blindly using softwares for evaluating plagiarism is a good example of why bad rules fail to have any effect. It also shows our hypocrisy when a thesis/project report turns out to show definite plagiarism and we solely blame the student. What is the use of that ubiquitous certificate by the supervisor? He/she, if anything, should share a greater blame.

We should strengthen and nurture more robust peer review system at all levels within Indian science. Often, our committees consisting of very fair people show unfair judgments. This should worry us more than it does. Often, same set of people seem to be in committees at all levels and in all subjects. Surely, there is lot of untapped talent and wisdom in the country. Maybe our academies need to suggest that at any time no member will be a part of more than 2 or 3 committees. We need more credibility as role models for others to emulate our ethical behavior.

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Ethics of Publication

Subhash Chandra Lakhotia

Cytogenetics Laboratory, Department of Zoology,
Banaras Hindu University, Varanasi–221005

Srinivasan Chandrasekaran

Department of Organic Chemistry,
Indian Institute of Science, Bengaluru–560012

> *'Connaître, découvrir, communiquer—telle est, au fond, notre honorable destine'*
> *(To get to know, to discover, to publish—this is the destiny of a scientist"_*
>
> *–François Arago*
>
> *"Brevity in writing is the best insurance for its perusal "*
>
> *–Rudolf Virchow*

Introduction

In contemporary practices, research is more formalized and has become an integral part of both the academic institutions imparting higher education and institutions created for research. Besides the self-satisfying aspect of the act of research and dissemination of the new information to others under the ownership of researcher(s), the research output is also a major factor for assessing the competence and achievements of an individual, groups of individuals or an institution (Lakhotia, 2014b; Chaddah and Lakhotia, 2018). Since the most common contemporary form of dissemination of research occurs via books/articles that are published (hard copy and/or online soft copy), the owner of the new knowledge generated through research becomes an author as well. Research that leads to invention of new methods, processes, machinery, product, is disseminated after being patented to safeguard the commercial interests of the intellectual property of the inventor. Owner(s) of the patent(s) is (are) also author(s) (Chaddah 2018).

Scholarly work is published in the form of a book (single/multiple authored, or edited with multiple authors), articles in research journals,

conference proceedings or in preprint archives. Authors, journal editors, peer reviewers, and publishers together are involved in the act of publication of research output. Publication of an article in any of the above forms is an essential building block in the development of a comprehensible and reliable network of knowledge.

Research and the publication process are built on trust based upon the basic belief that information and data are collected and reported honestly without falsification and misrepresentation, so that the resulting literature can be used as a reliable basis for further work. Since there are huge career pressures to publish research outputs, unethical behavior on parts of authors, journal editors, peer reviewers and or publishers is unfortunately becoming more noticeable in recent times (Mayer and Steneck, 2012; National Academy of Sciences 2009; Tharyan, 2012). It should be noted that if a published work is subsequently found to be unreliable or dishonest, not only personal and institutional reputations are destroyed for good, research efforts building upon such published work also suffers significantly in a cascading manner. Therefore, it is important for all parties to follow the highest standards of ethical behavior. The Committee on Publication Ethics (COPE) has articulated very detailed notes on ethical practices expected of authors, editors, reviewers and publishers (https://publicationethics.org/resources/guidelines; also see ICMJE Recommendations 2017). Some general guidelines on ethical practices that should be followed in the course of a publication are discussed here.

Authors and Contributors

Authorship confers credit for the work that has been carried out to result into a publication. This has many important academic, social, and financial implications. It is implicit that authorship entails responsibility and accountability for the published work. As advised by COPE, an author should have contributed to the manuscript in at least one or more of the following ways:

- Significant contributions to conception and/or design of the work
- Acquisition, analysis, and/or interpretation of data generated/collected during the work
- Drafting/editing the work or revising it critically and thus contributing important intellectual content.

When a book, research article or other category of research output is authored by one person, it is implicit that all the research work related to that publication was essentially carried out by that person, and he/she bears all responsibilities. In multi-authored publications, however, it becomes necessary to clearly identify contributions of each author so that their responsibilities can be defined. In such publications, all the authors, however, have following collective responsibilities.

- To be accountable for all aspects of the work to ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved;
- Final approval of the version to be published;
- Each author should be able to identify which co-authors are responsible for which specific part of the work.

As most research work in recent times involves actual intellectual participation of more than one person in the given investigation, order of the authorship in multi-authored publications becomes important because often it is taken to reflect relative contributions. Such publications typically identify one or more authors as first authors, one or more as Corresponding authors and others, if any, as co-authors, However, in some groups, it is customary to list authors alphabetically, sometimes with a note that all authors made equal contributions to the study and the publication. The order of authorship should be a joint decision of the coauthors. All authors should be prepared to explain the order in which the authors are listed. Generally, these decisions should be agreed upon before starting to write the article. It is desirable to inform the Editor/Journal about the relative contribution of each author to the study at an early stage. All authors in a multi-author manuscript should agree to be listed and should approve the submitted and accepted versions of the publication. Any change to the author list should be approved by all authors including any who have been removed from the list.

The corresponding author of a manuscript is the individual who takes primary responsibility for communication with the journal during the manuscript submission, peer review, and publication process, and also generally ensures that all the journal's administrative requirements, such as providing details of authorship, ethics committee approval, documentation

related to clinical trials, collecting information on conflict of interest issues etc., are adequately complied with. The corresponding author may, however, delegate some of these responsibilities to one or more co-authors through mutual consent. The corresponding author must be available throughout the submission and peer review process to respond to editorial queries in a timely manner. Additionally, he/she should be available after publication to respond to criticisms of the work and cooperate with any requests from the journal for data or additional information, should questions about the paper arise after publication. In some cases, there may be a need to share the credit of being the 'corresponding author' with one or more co-authors. In such cases, all those designated as 'corresponding' authors are expected to share the above noted responsibilities equally, unless specified otherwise. Name(s) of the corresponding author(s) may come anywhere, in the order as collectively agreed upon. Those identified as the first author(s) would have carried out bulk of the primary work that forms the basis of the article to be published. Persons, other than those listed as authors may have contributed to the study in some ways. However, they do not have the right to be co-authors in the study because they do not meet the above noted criteria. All such persons should be duly acknowledged for their contribution to the study at an appropriate place in the article. Examples of activities that do not qualify a contributor for authorship are procurement of funding, general supervision of a research group or general administrative support. Those who provided only assistance in writing, technical editing, language editing, and/or proofreading do not qualify to be co-authors.

Undesirable Authorships

Some other types of authorship like guest authorship, honorary or gift authorship, and ghost authorship described below are grossly unethical, and therefore, unacceptable.

- *Guest Authorship:* It is defined as authorship based exclusively on the expectation on part of the other authors that inclusion of a particular name as co-author may improve the chances of the work getting accepted for publication or for other personal gains. It is unethical to include such "guest" author name since he/she made no useful contribution to the study.

- *Honorary or Gift Authorship*: It is defined as authorship based solely on a feeble affiliation with a study, e.g., head of the department/institution, whose name is included solely because of his / her administrative position. Another example of 'gift' authorship is the inclusion of names of colleagues on the understanding that she/he will do the same, with the sole objective of swelling each other's publication lists. These kinds of 'gift' authorship are highly unethical. Having multiple authors on research publications that emanate essentially from the work embodied wholly in doctoral thesis of one student amounts to unethical 'gift authorship', unless the actual work carried out by the doctoral degree candidate and by others who share authorship in the related publications is clearly identified in the thesis.
- *Ghost Authorship*: In this case, although the persons participated in the research, data analysis, and/or writing of a manuscript, they are not listed as authors in the manuscript or while filing a patent application. It is unethical to exclude names of persons who have, by general principles, to be included as authors. A different class of ghost-authorship, which may not be unethical, is where a person contributed to writing of a paper as a professional writer (on payment or honorary basis), but will not be a co-author in the final manuscript. Such help should, however, be acknowledged in the acknowledgement section, if required.
- *Anonymous Authorship:* Since authorship has to be transparent and requires accountability, it is improper to use pseudonyms or to publish scientific articles anonymously.
- *Surrogate Authorship:* There are instances where manuscripts are written or got written by someone else without any original data of one's own. Such papers are often published in 'predatory'/bogus journals. These acts are unethical and illegal.

In order to ensure appropriate credits to all those actually involved in a given research output, many research journals ask and publish information about the specific contributions of each listed author. A more widespread use of such practice would facilitate avoidance of unethical practice of including or excluding some persons as authors and at the same time let the readers know about specific contributions of individual authors.

General Responsibilities of Authors

All authors have certain basic responsibilities during the course of actual research and during preparation of a manuscript based on the research output.

- *Originality:* The authors should provide a statement corroborating to the originality of the study they have submitted for consideration. It is not unusual for some journals to request the authors to provide copies of reports on other studies (unpublished articles, manuscripts, and abstracts) related to the study under consideration.

- *Good Record-keeping and Maintenance of Data:* It is mandatory that researchers maintain daily log-books to record every day's work and results. Errors due to carelessness and negligence should be avoided. The results, with any substantiating image or data outputs, must be maintained for a reasonable period of time even after the data have been published so that any subsequent queries/doubts etc can be satisfactorily answered.

- *Plagiarism:* Plagiarism is the adoption of another person's ideas, processes, results, or words without giving suitable credit, including those obtained through confidential review of others' research proposals and manuscripts. It should be understood that something being freely available on the internet does not mean that it can be copied as such. The authors must be aware of the issue of data/idea plagiarism and its consequences. Plagiarism (including self-plagiarism) in a manuscript is unethical and illegal. If any information is derived from the web e.g. Wikipedia, where the details on authorship may not be available, due reference to the link should be provided. For the use of other's data, due permission from the copyright holder needs to be taken in writing and this should be preserved.

- *Honesty, Objectivity and Integrity:* Authors must follow honesty, objectivity and integrity and avoid bias in experimental design, data analysis, data interpretation, and reporting data, results, methods and procedures in all scientific communications. Fabrication, falsification, or misrepresentation of data is plainly unethical and should not be resorted to. Trimming outliers from a data set without providing

reasons or using an unsuitable statistical technique to enhance the significance of results is unethical and not permitted.

- *Conflict of Interest:* Authors should disclose any conflict of interest (personal or financial) that may affect research. Researchers should also avoid bias in peer review, personnel decisions, grant writing, grant approval and other aspects of research

- *Openness:* The authors should be willing to share data, results, ideas, tools, and resources, especially after publication.

- *Respect for Intellectual Property:* It is the authors' responsibility to honor patents, copyrights, and other forms of intellectual property. When privy to someone else's unpublished data/research plans (as a reviewer, editor or a visitor to a lab or member of audience at a lecture, etc.), one should not use the privileged or confidential information and/or ideas for one's own work without prior permission since this is 'idea plagiarism' (Chaddah 2018). It is unethical to use unpublished data, methods, or results of others without permission. Due credit should be given wherever required. Literature review should acknowledge relevant prior contributions of other people in the field.

- *Copyright Agreement:* While publishing an article, authors are usually required to assign copyright to the journal publishing their study. Assignment of copyright is a legal document in which the authors assign certain rights to the publisher. Generally, these agreements allow the authors to retain certain rights to the material. Authors must carefully read and understand the copyright agreement document. The content for which a copyright agreement is being signed must be original and not under copyright elsewhere. Authors should ensure that the study under consideration is original and does not contain plagiarized content since the original source may already be 'owned' by someone. 'Creative Commons' organization has defined different categories of copyright licenses which permit reuse of published material under defined conditions; these are followed/adopted by different publishers/journals. For details, see https://creativecommons.org/share-your-work/.

- *Disclosures:* It is mandatory for authors to be honest and objective when complying with journal submission requirements. This entails disclosures about the originality of the content, each author's actual

contribution to the study. Financial support and conflict of interest should be disclosed correctly.

- *Consent for Reuse of Published Material:* Authors sometime may need to reuse data and/or images previously published by themselves or others. Depending upon the copyright conditions of such material, they may need to seek formal consent of the publisher and/or original authors; in those cases which are not held under copyright, reuse may not need any formal permission. However, in all cases of reuse of text, data and/or figure, attribution to the original source must be made.

- *Confidentiality:* All communication between authors and the journal is to be treated as confidential. The identified corresponding author is the specific contact for all communication about the manuscript throughout peer review and the publication process. Authors should observe journal policy on communication with external peer reviewers.

- *Responsible Publication:* The primary objective of a research publication is to share the new knowledge with others to advance scholarship, rather than to just advance an individual's career. Therefore, anything that is published implies responsibility on part of author/s.

- *Public Announcement of New Results:* A work which is submitted and accepted for publication should generally be not announced in general public till its formal publication. The norms defined by the given journal for the purpose should be followed.

Ethical Conventions of Publications

- *Multiple Submissions:* It is unethical and illegal to submit the report of a study to more than one journal at the same time. If authors want to submit their article to another journal while it is under consideration elsewhere, they must formally notify and request the editor of the journal in which it is under consideration, about withdrawal of their manuscript from further consideration by that journal. All coauthors must agree to the request for withdrawal and this agreement must be made clear to the editor of the journal with which the study is under consideration. Only after the receipt of notification from the journal acknowledging the withdrawal, the authors may submit their manuscript elsewhere. Authors should inform the editor if they wish

to withdraw their work from review, or if they choose not to respond to reviewer comments after receiving editors' communication asking for revisions.

- *Multiple Publications:* It is unethical, and amounts to plagiarism, to duplicate or reorganize/reformulate existing publications into new publications by willfully disguising the sources of work. Slicing of a given study to produce several publications is also undesirable as the significance of the study may be lost because of the piecemeal information in each.

- *Suggesting Potential Reviewers:* Some journals ask author/s to suggest names of potential reviewer and, in some cases, also of those whom the author/s may not like to be reviewer because of potential conflict of interest. It is unethical to suggest names of potential reviewers on the basis of friendship/acquaintance which may enhance the likelihood of acceptance. It is absolutely unethical to suggest fictitious names as reviewers with self-directed addresses so that the authors become reviewer as well.

- *Error Correction in a Published Paper:* Author/s may become aware, after a work has been published, of some errors in data or their interpretation due to an oversight. If it was a case of inadvertent error in data collection or analysis or interpretation of data, all authors, if it was a multi-authored publication, should be informed, and the error and its nature and implications on the final inferences should be reported to the editor of the journal. Authors may publish, in consultation with the editor, either an erratum or a new paper to rectify the previous error in the same journal.

- *Withdrawal or Retraction of a Published Paper:* Author or editor or a reader may notice/suspect an act of deliberate mis-conduct, such as falsification of data or plagiarism etc. on part of authors in a published paper. This needs to be carefully investigated, especially by the journal, to establish the alleged mis-conduct. If established, all authors need to be informed about the same and either the author/s may decide to retract/withdraw the paper or the journal may publish, with due reasons, a retraction notice for the earlier published paper. Such acts of mis-conduct, when established, are to be dealt by the responsible institution/s following the regulations/laws in force at the time.

Where to Publish?

Once the authors are ready to prepare their research output in the form of a manuscript, they have to consider and decide about how and where to disseminate the new knowledge. In earlier times, this was usually done first at a meeting of academic bodies (Academies/Societies) where the participating experts would discuss the new findings. These could then be published as part of the 'Proceedings' of the meeting or could be published as independent monograph or book. Publication of conference proceedings continues as a forum for dissemination. However, the published proceedings of conferences organized by individuals or groups rather than by established Academies/Societies do not usually get a wider attention and often do not also follow serious peer-review process. Therefore, often such stand-alone publications are not given much importance. The most common mode of dissemination of research output is in form of publication in research journals, where the manuscript submitted by authors is subject to peer-review by one or more subject experts or peers before being published. In recent times, the practice of sharing the new knowledge, prior to formal publication in research journals, is to make the output available in the form of 'pre-print' through individual/institutional web-site and/or through organized 'pre-print' archives. Some issues that authors should consider while deciding on the mode of dissemination of knowledge are noted below.

Pre-print Archives

'Pre-print' Archives publish the manuscript as submitted by author/s, subject to some general conditions but without any prior peer-review. These provide a free eternal open-access to the original research output. Pre-print archives do not generally publish review articles. 'Pre-print' Archives facilitate 'post-publication' peer-review since any reader has the possibility of posting comments on the published material. This can help author/s in improving their work and in preparation of the final manuscript for publication in peer-reviewed scholarly journals. Pre-print archives help authors claim priority and also help in curbing 'idea-plagiarism' that can sometimes happen in the process of conventional publication in peer-reviewed journals. Pre-print archives are becoming common as they

provide free open-access to new findings without any hindrance. Research output available on pre-print archives is also being increasingly accepted for assessment of individuals/institutions.

Peer-Reviewed Scholarly Journals

Scholarly journals may publish only review article or only original research articles or a mix of the two. A given journal may be broadly multi-disciplinary or may limit its scope to specific wider or specialized subject domain. Journal may be published only in hard-copy or only as online format or in both forms (hybrid journals). A given journal may not levy any charge on authors or may varyingly charge on various counts (charges for manuscript processing, number of pages of the published article, color image reproduction, open access etc.).

The number of scholarly journals being published is continuously increasing since publication in peer-reviewed journals is the most common mode of research output dissemination and its assessment. While selecting the journal where author/s may want to submit their new manuscript, following points should be considered.

- The journal has proper credibility and reputation. Journal of longer standing in the field should be preferred. However, the so-called 'impact factor' should not become the major determinant in the choice of a journal.
- Journal is published regularly and punctually, and should have well-defined peer-review and editorial policies.
- The journal is likely to be read by fellow workers who would be knowledgeable about and interested in the given subject domain.
- The journal should have a policy of publication of the category of article (review/original research article/ letter to editor, commentary/ opinion etc.) that is desired to be published.
- Journals, whose previous history of publications indicates an unduly longtime taken to publish submitted articles, can be avoided.
- Author/s should look at the articles published in the given journal in recent times to assess their quality and scope.
- While preparing a manuscript for submission to a journal, author/s must carefully understand and follow the instructions to authors provided by the journal about general layout and length of the

manuscript, style of citing references in text and in the list of reference, quality and sizes of illustrations etc. to avoid outright rejection or delays.

- Generally, negative results are not published by authors as well as most journals. However, in some cases, the negative results can also be significant and may help modify an existing model or may help others in planning their own studies. Some journals in recent times have initiated publication of negative results and these may be selected for such instances. Alternatively, authors may place such results as pre-prints.

- Publication in journals published by established academies/learned societies/universities etc. are to be preferred over those published by commercial organization (Lakhotia, 2014c). They are expected to follow the best practices and have no commercial element in their publication.

- Payment of open access charges should generally be avoided since the copy-right laws do not restrict author/s in sharing their published material with peers in the form of hard- or soft-copy (e.g. as pdf files) anywhere in the world (Lakhotia, 2017).

- Several institutions differentiate between journals published within and outside their country. Such distinction is unethical (Lakhotia, 2013a). Author/s and regulatory agencies should not follow it. It is the quality and the content of paper that should be used for evaluation and not the impact factor of a journal where it is published (Lakhotia, 2014a; Chaddah and Lakhotia, 2018).

- Authors must avoid 'Predatory' or bogus journals (Lakhotia, 2015), which charge a fee to rapidly publish 'anything' without peer-review. Due care should be taken while submitting a manuscript to a journal which levies publication or other charges to ensure that the journal is not a predatory/bogus. Publication in such bogus journals is unethical and often not recognized.

While submitting to a recently started new journal, its authenticity and quality should be carefully ascertained to ensure that the journal is not of 'predatory' or bogus category (Patwardhan *et al.*, 2018).

Responsibilities of the Editors

Most journals appoint a chief-editor and several sub- or section-editors and members of editorial board. Generally, the chief-editor, being the point of reference for most correspondence relating to a submitted manuscript, has the major share of responsibilities in all matters relating to processing of submitted manuscripts till their rejection/publication as well as to deal with any post-publication/rejection activities. In majority cases, the editorial positions in journals are honorary and, therefore, the editorial job is done more for the love of labor and prestige associated with it.

Editors (all categories) and their decisions play important roles in ensuring the quality of published material and thus the overall prestige of the journal. Their responsibilities include getting timely and informed peer-reviews on the submission, check of linguistic properties of the text, quality and adequacy of data and any illustration material in the manuscript, appropriate formatting of the text for publication, getting proofs corrected in time and finally to publish with good quality in scheduled time. The following general ethical aspects need to be followed by editors (Galipeau *et al.*, 2016).

- Editor of a journal must be academically competent in the given domain of the journal and must have a liking for editorial activities to be able to discharge the responsibilities with effectiveness and authority.
- Prior to accepting the appointment as chief-editor or editor of a journal, the person should find out not only the nature of responsibilities, but also the quality-policies of the journal and its publishers.
- All editors must agree to devote the required time for discharging their editorial duties so that the editorial work does not get delayed/postponed.
- An active researcher may perform better as an editor since he/she is expected to understand the nature of research and expectations of authors.
- All submissions should be submitted by the editor to check for plagiarism, quality of illustration materials.
- Most journals receive many more manuscripts than can be published. In many cases, editors can outright reject/return a submission because of obvious poor-quality or its being outside the scope of the journal.

Policies for such rejections should be well-defined and available to potential authors.

- Editor should promptly select peer-reviewers with due care about their expertise and experience in the field.

- Due confidentiality of the review process, where single- or double-blind review system is adopted, has to be maintained. Even when the reviewer names and comments are subsequently made public, due confidentiality needs to be maintained at early stages of the single- or double-blind review system.

- Many journals ask authors to suggest potential reviewers while some others also ask names of those whom they may not like to be reviewer for possible conflict of interest. In either case, editor must apply his/her own knowledge, experience and judgment to agree or disagree with authors or act otherwise. If the reviewer name/s suggested by author/s turn out to be fictitious, editor must decline the submission besides also reporting the ethical mis-conduct to the institution to which the author belongs.

- Editors need to ensure timely receipt of comments on the manuscript from reviewers. Most online submission software used by different journals provide for automatic reminders to reviewers. Undue delays can adversely affect author and also to the prestige of the journal.

- Editor should also personally evaluate the reviewers' reports and authors' responses to take an informed judgment rather than merely acting as postman between the two parties.

- If an editor happens to be an author in a submission to the same journal, which follows blind or double-blind review process, the manuscript should be processed by someone else in the editorial team in a manner which precludes the editor-cum-author in this case to have any access to the review process.

- Editor has to ensure appropriate copy-editing of the manuscript to take care of linguistic issues and formatting of references, figures, tables etc. and to get timely proof corrections and subsequent publication.

- Editor's responsibilities continue post-publication as well, especially when questions of priority, plagiarism, unethical manipulation of data etc arise. In such cases, proactive and informed action and decision need to be taken.

- The published articles should carry information about the dates of original and revised submission, if applicable, and date of acceptance. All efforts should also be made to publish online version as 'ahead of print' soon after the manuscript is accepted.

Responsibilities of Reviewer

Reviewers play a major role in publication of a manuscript in a journal. In most cases, the act of reviewing of scholarly publications is an honorary work rather than a paid service. The quality of peer-reviewing shapes the prestige of a journal in the discipline since they act as watch-dogs for ethical conduct of research and correct presentation of data and the claims made thereon.

The different models of pre-publication peer-review, which are currently in practice, vary in several features as noted below:

- *Timing:* Pre-publication in case of all peer-reviewed journals while for Pre-Prints it is Post-publication.
- *Identifiability:* in pre-publication double blind peer-review, neither the authors nor reviewers know each other's identity; in single blind mode the reviewers know author identity but authors do not know who the reviewers are. In pre-publication open review, each knows identity and reviewers' identity may also be made known to readers when the article is published. Reviewers' comments and author replies may also be published in some cases with or without divulging reviewer identity. In the post-publication review of published pre-prints, identity of peers who make a comment is known.
- *Mediation:* In most cases of double- or single-blind review, editors mediate between reviewers and authors. In some cases, reviewers can interact openly with each other, but not with authors. In the fully open review system, reviewers, author/s and editors openly interact with one another.

To be fair to editors and authors, peer-reviewers should follow the general ethical practices (Moore, 2012; Lakhotia, 2013b).

- A reviewer should accept the given responsibility only if adequately competent and knowledgeable in the field and should follow the timeline provided by the journal for submitting comments. One should

be willing to accept the responsibility of peer-reviewing as part of professional requirements. If for some reason one is not able to accept the reviewer responsibility, the editor must be promptly informed.

- Any possibility of a conflict of interest should be immediately reported to the editor.
- Reviewers should remain conscious that as active researchers, they themselves are or may have been authors and thus should provide adequate 'space' to authors to express their interpretation of the data, especially if that is not in full agreement with the current views (Lakhotia, 2013b). It is an established fact that only those publications that show inadequacy of the existing models/theories etc. and, which come out with newer ideas, often make a real advance in the understanding.
- Reviewers should check for originality in the question/s addressed and some novelty in findings that permit some advance in understanding using valid methods/materials/experimental designs etc.
- Reviewers should also examine any possible unethical practices that may have been used by authors and inform the editor/journal about the same.
- Reviewers should also be conscious of the fact that the authors who decided to undertake the given study did so with certain context and proceeded in the way they did because of their own reasons and that they wrote the manuscript in the way they did.
- Reviewer should not try to impose their own preferred hypothesis / theory or experimental designs etc. Review should be constructive in critique of the work and the manuscript so that even if it is rejected, authors can make use of the reviewer's comments and suggestions in improving the future research output.
- Information in the article available to the reviewer as part of pre-publication review is confidential and privileged, and, therefore, reviewer should not use such information for one's own or someone else's advantage. Involving someone else (e.g., a junior colleague) in the review process should not be practiced without permission of the journal. If involved, their identity should be made known to the editor for record and for giving due credit for the effort.

- Editor expects an honest and unbiased assessment of the strengths and weaknesses of the article under review. Reviewers are usually required to provide confidential comments to the editor and more detailed comments to be read by the authors. Most journals also require a clear recommendation to accept/revise/reject. Such recommendation should be supported by the comments to editor and author.
- Reviewers should be willing to re-review a revised version, if so requested. They should generally refrain from raising new issues, unless arising from the revised content, for the sake of rejection.
- If an editor has to also review the submitted manuscript, it should be done transparently, rather than as an anonymous reviewer.
- Confidentiality of the review process in single- or double-blind system has to be maintained following the journal's policy and this responsibility continues even after publication/rejection of the manuscript that was reviewed.

Responsibilities of Publishers

All research output needs a publisher to widely disseminate the research output in a hard-copy and/or online formats. Publishers who disseminate research output in the form of journals, monographs, books (authored or edited) etc., are established scholarly societies/academies or academic institutions or commercial publishers. Occasionally, individuals or academic institutions may also publish proceedings of a conference as a stand-alone volume. Recent years have witnessed an increasing involvement of commercial publishers in dissemination of scholarly works, which unfortunately, also has brought in some unethical practices (Lakhotia, 2017). Some general ethical principles that should be followed by publishers of scholarly articles are noted below.

- Publication of research output is a societal responsibility and, therefore, should not be taken as a purely commercial activity (Lakhotia, 2014c).
- The announced schedule and frequency of publication is to be maintained.
- Publishers should not take recourse to artificially enhance the citation/ impact factor of journals.

- Publishers must not interfere in academic freedom of editors and editorial board in processing of the manuscripts submitted for publication.
- Publisher must provide adequate infrastructure support to editors in discharge of their duty and responsibilities.
- Details of editorial, review, ethical and publication policies of the journal must be transparent and available for anyone to see. Author guidelines and information about any charges payable by author/s should be clearly stated.
- Any charge payable by authors should be payable only after acceptance of the manuscript, unless a journal levies submission charge.
- Where ever possible, author charges may be relaxed or waived off, if the authors are not able to pay because of limited resources. In any case, the peer-review and acceptance of a manuscript should be dependent upon academic merits rather than the payable charges.
- Publishing of 'predatory' or bogus journals, which would rapidly publish 'anything' on payment of a fee but without sensible peer-review is absolutely unethical (Lakhotia, 2015; Patwardhan *et al.* 2018).

Ethics of Retraction

Publishers, editors and reviewers of all scholarly publications have to be vigilant to avoid any possible unethical mis-conduct on their part or on part of authors. Yet, there would be cases when instances of diverse categories un-ethical practices in published work are noticed after publication by reader, author, reviewer or editor. Any such situation must be immediately brought to the notice of Editor/Publisher who then has to initiate proper enquiry, which would also involve seeking clarifications from the author/s. The course of action to be followed should be as suggested by the COPE guidelines, which the scholarly journals and publishers are required/expected to adhere to. Depending upon the seriousness of the unethical mis-conduct, authors may publish an 'apology' note, or editors may publish 'expression of concern' or retract the paper. In more serious cases, the editor is expected to inform the authors and the concerned host institution about the mis-conduct.

Besides the intentional or un-intentional unethical practices, cases of errors in judgment/interpretation of data may also be noticed by authors/ readers. Such cases need to be dealt with differently by author/s, editor and the journal. They may agree to publish an erratum or even a new paper to clarify the earlier error/mis-judgment.

Concluding Remarks

Professional involvement in research is primarily an outcome of our innate curiosity and thus, primarily has a self-satisfying goal. However, when properly disseminated, research also adds to the collective increase in knowledge and understanding of the human society and leads to technological innovations and advances which have more profound consequences. Assessment of research output of an individual or institution also has significant consequences for the professional advancement. Following appropriate ethical guidelines at every step of research and its dissemination obviously adds to the pleasure of researchers as well as the target audience.

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Ethics in Science Governance

Manohar Lal Munjal

*Department of Mechanical Engineering,
Indian Institute of Science, Bengaluru–560012*

Ashok Kumar Singhvi

Physical Research Laboratory, Ahmedabad–380009

> *The philosophy of the school room in one generation
> will be the philosophy of government in the next*
>
> *—Abraham Lincoln*

Introduction

Ideally science is an individual driven creative activity and scientific progress in a broad sense results from the fair play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown (Bush, 1945). Nevertheless, as the consequences of scientific research have deep impact on society, governance of scientific research, whether it be at the level of an individual scientist making a choice of the problem to work on, or by the agencies providing funding, or the government through its policies, etc. involves key ethical issues.

Over the last 500 years scientific enterprise has grown enormously. In India, science is mostly public funded through legislative action. An Estimated 200,000 scientists work in India (www.nature.com/news/India-by-the-numbers-1.17519) both in R&D institutions and in the larger sector of universities and, in PG/UG colleges. Amartya Sen (2009), quotes Hungarian polymath and thinker, Michael Polanyi who pondered deeply 'about the knowledge of the world and the world of knowledge' and put forward the view that scientists are the best judge to determine what research to do as they understand best the issues involved (Polanyi, 1962). Although not everybody agrees with this position (Tyler, 2013), even today, more or less, scientists themselves organize, govern and

regulate their enterprise. Governments decide science policies and thrust areas in them, in broadest terms. Every component of scientific enterprise at different levels is carried out by and large by sub-groups of scientists themselves. Governance is thus done basically by sub-groups of working scientists and at times by professional bureaucrats and other entities.

Professional ethics in decision making at all levels of governance should therefore be seriously considered by the decision makers. It is in the vested interest of working scientists that governance of scientific activities is carried out keeping this in mind.

This chapter discusses different areas of science governance where ethical conduct is of crucial importance. Interested reader may also like to see the discussion paper on the subject published by the World Commission on the Ethics of Scientific Knowledge and Technology (Report of COMEST 2015). A major factor in these arises from the issues of conflict of interest.

Conflict of Interest

Cambridge Dictionary defines conflict of interest (CoI) as a situation in which someone's private interests are opposed to that person's responsibilities to other people i. e. a situation in which someone cannot make a fair decision because they will be personally affected by the result. Transparency is an essential ingredient of any governance process and the conflict of interest then becomes a serious component of this process, though often overlooked, either through deliberate design or through sheer ignorance. Both have detrimental effect on the fairness of any process of evaluation.

Conflict of interest can arise from personal issue when one sits in judgment of his kith and kin and colleagues with a prospect of providing them undue favor. This can also arise from institutional affiliations where one could favor his institution or colleagues for some gains or for an eventual quid pro quo. It could also arise from similarity of research problems being pursued by two groups and one holds back the review of the other to gain time for his work to be first published. These acts give rise to nepotism and compromises on the aspects of scientific integrity. Normally under such cases it will be desirable to opt out of evaluation process, when even a minor conflict of interest is seen. In many committee

meetings overseas and now often in India, all the members do make a formal statement on possible conflicts of interests and it is up to the wisdom of the Chair and the committee to take a call on such statements. The CoI applies of all cases where a selection or a choice is to be made. These include all aspects ranging from election of fellows in the academies to the selection committees, purchase process, promotions, peer review process and everything. One needs to be conscientious in these matters and use his/her judgment in each situation.

Assessment of Research Output and Impact

Peer assessment of the research output of a scientist is necessary in order to:

a. Measure its impact on the state of the art, i.e. the contemporary science;
b. Appreciate the scientist's contribution to the society which supports his/her research, although indirectly;
c. Check if the research grant or funding has been utilized properly;
d. Assess the particular scientist's standing with respect to his/her contemporaries in the scientific world;
e. Decide upon his/her suitability for promotion to a higher rank or chair.

While the subjective factor is unavoidable and indeed necessary in peer assessment, quantitative assessment of the scientist's research output in terms of, 1) the number of papers published in peer-reviewed journals and presented at conferences in India and abroad, 2) impact factor of the relevant journals, and 3) the citation and the H-index, are also needed for objective assessment of performance of the scientist under review. In doing so, care should be taken that these indices are used only as indicative judgment and it should be ensured that the quality of work itself is rigorously evaluated by the expert/committee. This requires due diligence on the part of the experts/committees.

Unbiased assessment of the scientist's research output and impact involves the following ethical issues:

- The reviewer(s) selected for peer assessment should not be in any way, professionally or personally, related to the candidate to minimize any possibilities of nepotism, parochialism and favoritism.
- They should be sufficiently competent in the area of the candidate's proposal and above board. The committee should comprise people of core competence to professionally examine the vision of the candidate vis a vis institutional mandate.
- There should be no conflict of interest in the subject matter of research of the candidate and the reviewer.
- The assessment procedure should be as transparent as possible. The reason and process, and merits/demerits of the case be recorded explicitly and if possible be placed in public domain.

Record keeping is an essential aspect of such activities and as far as possible both written and audio recording of the meeting should be preserved for future scrutiny.

Funding of Sponsored Research

The academia and scientists depend on public money for the purchase of necessary equipment(s), software, consumables and services, and for supporting their research assistants and associates. For this, they apply to the funding agencies (mostly public) through project proposals prepared in a specified format. These applications are generally peer reviewed. Subject to positive reviews, the PI is often invited by the appropriate Program Advisory Committee (PAC) to make a presentation and answer the reviewers' questions. Based on this presentation, the PAC makes recommendations to the funding agency (like SERB/DST, DRDO, DAE, CSIR, AICTE, ISRO, etc.) for full or part funding. Often the PAC reviews the project periodically for progress or fulfillment of the project objectives or deliverables. It is eminently desirable that the parameters for evaluation are decided *a priori* and made known to the candidates in advance.

For judicious utilization of the tax payers' money, the project must lead to

- publication of papers in reputed journals thereby leading to tangible progress to our understanding of the natural forces and phenomena; or

- amelioration of public suffering by helping purification of air, water, or environment in general; or
- some product/process/technology of use to industry or public at large; or
- augmentation in yield and quality of crops; or
- prevention and/or treatment of diseases leading to mitigation in human suffering.

Success in this whole process of sponsored project depends on the following ethical issues:

a. The process of selection of projects for full or part funding should be transparent so that the prospective PIs know in advance what to expect, how to formulate a good proposal, how to defend it, how to execute it, and how to further their research career through successful execution of the project.

b. The chosen reviewers of the project proposals should make sure that there is no conflict of interest.

c. Members of the PAC should be accomplished scientists or academicians with proven track record so that they can do justice to the job of advising the funding agency. The onus here lies with the funding agency to identify and approach such persons. It is eminently desirable that during their tenure the members of PAC/PAMC do not submit their project to the committee or if they must then recuse from the entire process. The chair may co opt experts for such cases. *Sensu stricto*, any committee funding its own members without recorded statement on conflicts of interest is grossly unethical and should be scrupulously avoided.

d. The funding agency should call for project proposals in the identified thrust areas if they want to ensure social relevance or applicability of the project outcome. Of course, this would not apply to project proposals in fundamental research, which in the final analysis are equally important.

e. The handling scientists at the funding agency must always remember that they are discharging a public duty; they should not adopt the attitude of a 'giver'. They should understand that they are not doing a favor to PIs by releasing the sanctioned grant in time. They should

also refrain from seeking personal favors from the funded PIs or their institutions. The committee members should explicitly refrain from seeking any favors from the PI.

f. For large or costly projects, there should invariably be a Co-PI to ensure that the project is not abandoned midway if for some reason(s) PI leaves the institution or is unable to carry on further for a variety of reasons. Institutional guarantees for any proposal for its successful completion should be an essential requirement for any publicly funded proposal. It is unethical to let a project suffer both due to the movement of people concerned as also due to bureaucratic hurdles. It is desirable for institutions to have separate account for research projects for ease of accounting and accountability.

g. Implementation of proposals in a timely manner is also important. This implies ethical conduct on the part of the Finance and Administrative authorities to release grants in a timely manner so that the work is done in a smooth, seamless manner. Delay in funding negates the basic tenets of research, which needs to be contemporary. Appropriate checks and balances should exist in any funding system for a timely disbursal of funds. Also the perspective with which a project is funded should be kept in mind while evaluating the financial and administrative aspects. Science capacity building should be viewed as an important national objective.

Ethical Aspects of Recruitment

Institutions are made (or marred) by the quality and attitude of their scientists or academicians. Therefore, recruitment of scientists or younger faculty is of crucial importance. The head of the institution must pick up his/her senior advisors extremely carefully, who then may be charged with identifying, recruiting and nurturing promising young scientists. For example, (Late) Prof. Satish Dhawan, as Director of the Indian Institute of Science, would make it a point to personally chair every selection committee not only for the selection of lecturers or scientific officers but also Senior Research Fellows who could eventually rise to become Assistant Professors. He would find time for this important job even when he was simultaneously the Secretary of Space. To ease this process, he

created the posts of Divisional Chairmen, who would in turn involve international reviewers for recruitment and promotion of the Institute faculty. The Divisional Chairmen would paraphrase and present the reviewers' reports to a standing Promotion and Assessment Committee (PAC) consisting of distinguished academicians, which would then make appropriate recommendations to the Governing Council. This practice has served IISc very well and has helped the organization to reach and retain its position as a world class institute.

Every recruitment exercise must avoid the following ethical pitfalls:

a. The entire recruitment process must be transparent to all aspirants;

b. The relative importance of the different assessment criteria should be understood and adhered to by all members of the selection committee;

c. None of the selection committee members should have an apparent conflict of interest, or else the concerned member should excuse himself/herself from the exercise;

d. The selection committee should guard against any non-technical or parochial considerations; merit must be the predominant criterion. They must remind themselves of the proverb, 'one bad fish can spoil the whole pond';

e. The expert members identified for the selection / interview committee must have impeccable academic/scientific credentials as well as integrity.

Organizations/Institutions should guard against the tendency to poach from sister institutions as this does not help the nation. To an extent however this is unavoidable and should be examined on case to case basis – exclusively on the aspects of scientific merit and on the long-term interests of the institution and the individuals.

Ethical Aspects of Social Recognition of Scientific Excellence

Some academicians and scientists have a tendency to announce their research findings in the social media and local newspapers before communicating the same to a peer reviewed journal. This is unethical. Social recognition naturally follows when a scientist gets recognized by his peers. However, some of the scientists who may not have the caliber

or strength to face critical peer review, tend to resort to the practice of using the social media to create pressure on their institute authorities for augmentation of their career. This is unethical.

There is, however, another aspect to this unethical practice. The science correspondents of the news media often sniff around the Institute/ Laboratory campuses for sensational stories for their periodical science columns. Scientists should refrain from talking to these correspondents about their unpublished work. This is the job of the Institute Information Center or Public Relations Officer, who would apply the necessary filters or checks before sharing the scientific stories with the news media. Such official hand-outs would neither embarrass the Institute nor mislead the public.

Of course, the Institute or Laboratory authorities should be happy to share the exciting or promising discoveries made by its scientists/ academicians with the public, and the credit or social recognition would accrue to the concerned scientists. This would be an ethical practice.

Ethical Aspects of Funding Policies

Do the Means Serve the End? Capacity Building vs. Achievement of Excellence

Several universities/institutions in India have magnificent buildings and open spaces. However, there are comparatively little funds for the maintenance and working expenses of scientists/faculty. Many of these institutions have beautiful laboratory spaces which are however ill-equipped and/or suffer from poor maintenance. This policy or practice of capacity building at the expense of excellence in achievement is basically unethical. Impressive facades and infrastructure deceive the public (including NRIs) and lots of students are enticed into seeking admission in such institutions paying high fees, and they finally pass out with sub-standard level of education. A large percentage of such 'cheated' students are unemployable and remain unemployed or underemployed for no fault of theirs.

Another aspect of this problem is the tendency of some scientists/ academicians to equip their laboratories with latest/costly equipments (electron microscopes) and keep publishing tons of papers on material

characterizations. There is little or no new science in this kind of work. While capacity building is necessary to some extent, it cannot be an end in itself. Scientific excellence should be showcased; not just advanced imported equipments. It does not behove a scientist to reduce himself/ herself to a research assistant or laboratory technician as that can be construed as unethical use of public funding.

Ethical Aspects of the Choice of Academic Leaders

For a healthy scientific environment, leadership is very crucial. An efficient and distinguished leader would attract and nurture capable and promising scientist/faculty. On the other hand, a leader of mediocre credentials would repel talent and excellence. For his/her own survival, he/she would appoint only mediocre staff, thereby doing permanent damage to the institution. Devoid of academic vision and leadership, such leaders often pride themselves on the creation of infrastructure and other non academic matters.

Therefore the choice of academic leaders is of paramount importance. In the past several education commissions and committees have emphasized the basic criterion for the choice of leadership. Thus, for example, the Kothari Commission states that, 'A Vice Chancellor should be a person with vision and (have) qualities of academic leadership with ability for administration. He should command high respect among all sections of the society. The Vice Chancellor should be a distinguished academic... have commitment to the values for which the universities stand….He must have the ability to provide leadership to the university by his academic worth, administrative competence and moral stature (Kothari Commission 1964 66:334)'. Such a vision is applicable to the entire spectrum of scientific leadership and any deviation from such vision on the choice of leadership in Science will be an unethical practice.

Academic leaders should have impeccable credentials so that their younger colleagues look up to them with awe and respect. To choose such leaders, the search-cum-interview committees must be manned by eminent scientists of high integrity, known for their fair practice and for whom scientific standing and leadership potential of the candidate should be the primary criteria. Succumbing to non-technical considerations must be eschewed.

Confidential reports from distinguished or established peers can be a good source of impartial and considered advice. This, however, is subject to proper choice of reviewers as well as search committee members. It will be necessary that all the evidence used in the final selection be decided *a priori* and then recorded *sensu stricto*.

It is important to avoid inbreeding as far as possible or feasible, otherwise the selected scientist or academician will not be able to exercise authority. More importantly, an inbred leader may bring with him/her prejudices and obligations which may adversely affect his/her decision making. The umbilical cord of a student and his department/institution must be broken, as it were. Besides, inbred leaders, with their pre-conditioned minds, often find it difficult to get out of the rut and are unable to look for out-of-the-box solutions for the deep-rooted problems in the system.

Ethical Aspects of Establishing and Organizing Centers, Departments, Schools and Institutes – Static vs. Dynamic Models

The Director/Vice Chancellor of an Institution/University should have a vision to establish and organize new centers, departments, schools and institutes. They should not be impulsive or parochial. Nor should they set up a new Center just to accommodate or placate a particular scientist or appease a vocal lobby.

Perpetuation of the conventional setups or laboratories constitutes a static model of science administration. In keeping with modern trends, the Director may choose to think beyond the conventional contours and establish new schools of study and possibly close down less contemporary areas. In Germany for example, each centre of an academy has a well-defined tenure and on their completion, centers in new areas get initiated. This ensures the vibrancy of the academic system. As more and more of the present-day research is multi-disciplinary that calls for a dynamic model of administration as well as leadership.

Due diligence needs to be applied to the need of a new center, and how it would fit into, or add to, the existing centers. It is very important for the Director or Vice-Chancellor to seriously consider the long-term

maintenance or sustenance of this new center and ensure that the funds will be available. Often funding is available for setting up a new center for an immediate perceived need, but not for its healthy maintenance. Self-sustenance of the center is a desirable feature and must be considered seriously right at the start. Absence of a well reasoned and deeply researched economic viability model for a centre also in a way constitutes an unethical practice.

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Ethical Practices in Science Outreach

Sunil Mukhi

Physics Program, Indian Institute of Science Education and Research, Homi Bhabha Road, Pashan, Pune–411008

and

Nandula Raghuram

School of Biotechnology, GGS Indraprastha University, Sector 16C, Dwarka, New Delhi–110078

> *Relativity applies to Phyiscs and not Ethics*
>
> *–Albert Einstein*

Outreach as an Obligation

Scientists have a duty and an obligation to communicate the results of their work to the public and contribute to improving public understanding of science. This is particularly important when the scientific work is publicly funded. In a 1985, a policy document of the Royal Society of London (Report of Royal Society, 1985) observed that "Scientists must learn to communicate with the public, be willing to do so, and indeed consider it their duty to do so."

All Scientists who do science using public funds are obliged to convey their work to an average person in simple language which they can understand and appreciate. Additionally this is also in the interest of scientists, since continued funding critically depends on public support. Another motivation of science outreach is that it inspires young students and can influence alignment of their career trajectories towards the direction of front-line scientific research.

Numerous channels of communication exist and these can be and should be explored. On the one hand, there is the press, while on the other there is the enormous reach of social media. In the latter category,

blogs and popular science magazines are venues for scientists to write in their own words and reach public directly in a manner unimpacted by intermediary authors or be limited by the restrictions of space. Beyond the written media, the scientific research being done in in the country can be highlighted and communicated to the public through lectures and demonstrations/workshops at colleges, schools and public venues. Lectures like these, and even courses, can be recorded and shared on video channels and on WhatsApp like media.

Research has indicated that "Videos benefit teachers and learners, stimulate stronger course performance in many contexts, and affect student motivations, confidence and attitudes positively", (Carmichael *et al.*)

The World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), a part of UNESCO, provides several useful inputs regarding science outreach in its report "Ethical Perspective on Science, Technology and Society: A Contribution to the Post-2015 Agenda" (COMEST Report, 2015). This report observes that "At the most general level, based on article 27(1) of the Universal Declaration of Human Rights, access to scientific information may be regarded as a human right." In relation to scientific outreach, the document raises concerns about "patterns of exclusion in public consultation" and advises that in making decisions on controversial technologies, the citizens of a nation be effectively consulted and represented. This concern interfaces that are created through scientific outreach, positing it more as a two-way than one-way activity.

A relatively recent area of immense ethical concern is Genome Sequencing and Editing. Ethical questions abound in this field because the possibility of making changes to human genes raises the risk of dramatic and unforeseen consequences. Before deciding on what experiments in this field are permissible, experts need to interact with the public to highlight both the benefits and the risks. A recent Editorial (2017) in The Lancet addresses this subject, and concludes that "Perhaps the overarching message from the fast-evolving work of human genome editing lies in the importance of engagement: the interdependence of science, ethics, and public consultation."

Ethics in Communicating Science

The manner of public communication of science must follow certain ethical imperatives. In the process of science communication, the scientific achievements and progress, as well as its potential consequences, should be highlighted over and above individual personalities or institutions. Promoting any result excessively and in a manner so as to project individuals, or conversely criticizing the work of others excessively and in a manner to deliberately harm their image, are unethical.

Beneficence is one of the key principles of ethics of science. The most convincing justification for social investment in science is that it is for the universal good, in general and the public good or national or global good in particular. Yet, some societies have also seen how science and technology has been used for war, exploitation and disempowerment. It is important not to use scientific jargon to justify unsustainable models of development that cause displacement and disempowerment.

Society has a right to be concerned and informed about what is practiced in the name of science, and whether it is communicated properly or not. At the same time, the scientific community should be concerned about the use of science to legitimize inappropriate beliefs, products and practice. In this sense, the ethics of scientific outreach not only relates to how scientists communicate their science, but also about how others use science to communicate policies and opinions in society at large.

Scientists in advisory, consultancy or regulatory roles in expert committees can be at risk of imparting scientific legitimacy to a questionable policy, technology, product or practice. This is particularly relevant in areas like environmental impact assessments, clinical trials, field trials and development projects. Independent peer review or third party scrutiny of regulatory data is important to ensure that regulatory exercises become matters of science rather than faith.

Some principles of ethics that scientists are advised to keep in their mind when they communicate their scientific findings or that of others in their field are; do good, do no harm, respect privacy, respect confidentiality, be sensitive to vulnerable people and the environment, maintain scientific objectivity, adhere to truthfulness and healthy skepticism, declare caveats

and conflicts of interest and, avoid self-aggrandizement in whatever is communicated and the way it is communicated.

Often the public believes every statement made by a scientist to be scientific and true, but the public credibility of science will survive only as long as such a trust lasts. Even a few incidents wherein this trust is betrayed or not taken seriously can irreparably damage the effectiveness of science communication and the credibility of scientists as a community.

In particular, public confidence in science can be undermined if claims are frequently reported and then contradicted/retracted. Hence, scientists are urged not to announce results in haste and in misleading ways in public fora till they have been peer-reviewed and published. This is particularly important when these results can influence human behavior in the short term – notable examples exist in the field of medical research.

It is fair to say that in modern times, the old rules about actually keeping research findings confidential until publication are seen as outdated in many disciplines. The ArXiV has become a valuable method of quickly sharing research progress and establishing priority. Nevertheless, whether a work is first presented on an un-refereed archive or in a refereed journal, it remains a key responsibility of scientists to be careful that their publicly presented work is accurate to the best of theirs and contemporary knowledge. Online publication, in either un-refereed or refereed form, does have the advantage that other experts in the field can comment on the work and provide feedback to the media about how seriously it should be taken.

Despite these concerns, the requirement to be careful about publicly sharing research conclusions should not be treated as an excuse for scientists to remain in their shell and refuse to generate public understanding and support for their area of research. As indicated above, outreach is an ethical obligation as long as one remains within ethical boundaries in respect of scientific claims, their implication and provides proper credits all contributors.

In the present era, industrialized mass communication includes advertising and marketing of various digital and other media for educational, gaming and other purposes. Ethical concerns have emerged on the misuse of public trust in science to manipulate consumer behavior. Advertisements often try to impart scientific legitimacy to their marketing

claims via dubious claims, stated either in the language of modern scientific research or in the language of indigenous knowledge systems. All such acts are patently unethical. Advertisements for food and personal hygiene products often refer to scientific evidence that does not actually exist.

While there are statutory bodies for consumer affairs and advertising standards, the scientific community and its academies and associations has an ethical duty to oppose the unethical use of science in marketing. This aspect needs more proactive action on the part of scientific community.

Responsibilities of Journalists and the Public at Large

Any ethical duty devolves on journalists and those who report on scientific progress, as well. While the need for a dramatic headline may be understandable and space considerations may be important, journalists are expected not to overstate or oversell scientific claims, and they need to be careful to state caveats and exceptions, explicitly.

In the context of advertising, unethical scientific claims are extremely dangerous. Underplaying or exaggerating the risk of viruses, illnesses etc. and/or advising irrelevant actions and stoking fears is a social evil that has caused many fatalities and much damage. Similarly, making knowingly false predictions of weather or other events is highly damaging. This may cause large scale economic losses to millions and, if intentionally done for whatever reason, constitutes unethical practice.

The Advertising Standards Council of India (ASCI) may create a regulatory mechanism to carefully oversee advertising with scientific / medical claims, look into their veracity and ensure that potentially false claims are investigated and reported to competent authorities, when required. The Science Academies have a role to play and there is a need to develop a mechanism that in all such cases, Science is used, due diligence in verifying the science claims is carried out. Medical Councils and similar professional bodies can also keep a watch on such claims in the public domain and, if necessary, contact the relevant body responsible for standards.

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Ethical Issues Associated with Gender-Bias

Shobhona Sharma
Department of Biological Sciences, Tata Institute of Fundamental Research
Homi Bhabha Road, Mumbai–400005

Lingadahalli Subrahmanya Shashidhara
Department of Biology, Indian Institute of Science Education and Research,
Dr. Homi Bhabha Road, Pune–411008

Tanusri Saha-Dasgupta
Indian Association for the Cultivation of Science, Kolkata–700032 and
S.N. Bose National Centre for Basic Sciences, Kolkata–700106

Rohini Madhusudan Godbole
Centre for High Energy Physics, Indian Institute of Science, Bengaluru–560012

> *Achieving gender equality requires the engagement of women and men, girls and boys. It is everyone's responsibility.*
>
> **–Ban-Ki Moon**

Preamble

Discrimination in the workplace, based on religion, age, ethnicity, disability, skin color, caste, race or gender, is clearly unethical and in several contexts illegal. Articles 14-18 of the Indian Constitution provides for 'Right to equality'. While it is important for ethical guidelines to cover each type of discrimination, in this chapter we will limit the discussion to gender discrimination in the scientific workplace. While obvious incidents of sexual harassment are identifiable and have already come under legal measures, here in this chapter we also highlight various forms of gender bias, discrimination, which even if not covered in the legal framework, definitely need to be considered as a part of Academic ethics.

Gender Discrimination as an Ethics Issue

All Academic inquiries, be they scientific inquiries or otherwise, are based on the foundations of ethics as one should pursue knowledge without any bias, boundaries or fear. In pursuit of truth, honesty of methods of pursuit is an essential requirement. When such pursuit is a social endeavour, our interactions with our partners in this journey (our students, our colleagues, our staff etc) should be such that we uphold the ethical values of our profession and at the same time create an atmosphere wherein everyone participates in the academic journey with the same rigor without bias and fear. Given such ethical pre-conditions, gender discrimination and gender-based harassment are not only illegal, are also unethical. It would also cast doubts on the integrity of the academic work of a person who indulges in discriminatory practices.

Traditionally, discussions of ethics in the academic context have focused on issues like plagiarism and data fraud. For example, the 327-page document "Fostering Integrity in Research" produced in 2017 by the National Academies of Sciences, Engineering and Medicine of the USA (NASEM, 2017) works within the paradigm of Falsification, Fabrication and Plagiarism, known for short as FFP. This in turn was derived from a 1992 report on Responsible Science (NASEM, 2012) which defined scientific misconduct in these terms. In 2000, the United States government officially defined "Research Misconduct" to consist of FFP (FPORM, 2000). In recent times a number of articles and studies around the world have argued that gender-based harassment and bias in academia should be included in the definition of unethical behavior (O'Leary-Kelly and Browes-Sperry, 2001; Browes-Sperry and Powell, 1999; Mathews and Bismarck, 2015). It has been argued that identifying sexual harassment as a moral issue and not merely a legal one would actually be effective in causing it to occur less frequently. Recently a report (NASEM, 2018) was brought out by the National Academies of Sciences, Engineering and Medicine. The group, consisting of both social scientists and natural scientists, was given the task to evaluate influence of sexual harassment in academia and career advancement along with identifying as well analyzing policies and practices that need to be followed in this context. The conclusion of these various studies has been that ethical management of the workplace

is an important way to forestall the occurrence of harassment, without detracting in any way from the existence of laws and legal remedies.

Gender Bias in Academia

A persistent charge of women in academia, highlighted in (NASEM, 2018) among other references, is against a pattern of insidious low-level misbehavior or discrimination towards women. This may sometimes amount to unintentional bias, rather than explicit, actionable harassment, but is nonetheless very damaging. It renders the workplace unpleasant and unviable for the discriminated individuals on a daily basis, lowers their confidence level and impacts their ability to function on an equal footing with colleagues.

There are several types of inequities that exist in the workplace, perhaps for both sexes, but these are more heavily biased against women. This is apparent from the very small numbers of women reaching senior positions, even though the numbers enrolled for science degree courses is considerable. The male/female ratio varies historically, and while at present we see comparatively more women in medicine and biological sciences, it remains extremely low in physical sciences and engineering. Apart from social and family pressures for women towards obligatory roles for child and parental care, there is a gender stereotyping that identifies science and technology with masculinity. Moreover, despite the presence of legal guidelines for redressal, sexual harassment ranging from mild to physical abuse also causes irreversible damage to a woman's ability and desire to continue functioning in a given environment. Existing legal mechanisms can address remarks of a direct sexual connotation in the framework of sexual harassment. However, remarks originating from a biased perception of women's role and capability in the professional community are not easy to deal with in this framework. Yet, they do enormous damage by creating low self-esteem and supporting a dynamics of self-exclusion among women professionals. An optimal work-space is one where both women and men are sensitive to each other's needs and can learn to work with each other with dignity and respect.

Undesirable acts may include making insensitive remarks, use of inappropriate language and innuendos, objectionable behavior patterns

towards women colleagues, bringing up their personal lives or spreading rumors and so on.

In fact, the study reported in (NASEM, 2018), found that sexual coercion, unwanted sexual attention, inappropriate touching, the only type of sexual harassment in the public perception and the one to come under the purview of legal measures, is only the tip of the iceberg. Gender discrimination and gender harassment are also a part of sexual harassment and normally these are not perceived as such. Gender discrimination, very often not very explicit, in turn creates an environment where direct discriminatory practices are considered normal. It is also realized that high level of gender inequity in numbers at the workplace, can contribute to a gender unfriendly atmosphere. Hence one of the necessary, but not sufficient, measures to reduce gender discrimination is to address this inequity in numbers.

Existing Measures to Address Gender Inequity in Numbers in Academia

In India, in recent times special attention has been devoted to improve the enrollment, retention and advancement of women in higher education and scientific research. Department of Science and Technology and Department of Biotechnology have several specific schemes for women in science such as WOS schemes of DST. Several private agencies also sponsor scholarships for women for higher education e.g. Santoor Women's Scholarship by Wipro, Lady Meherbai D Tata education loan scholarship, and Women Techmakers Scholars Program, formerly named Google Anita Borg Memorial Scholarship. The latter offers financial support to undergraduate and graduate female students who demonstrate leadership qualities and excellent academic record. This is a one-time scholarship which encourages students in the field of Computer Sciences or related technical field. State sponsored programs, such as 'Kanyashree' in West Bengal have also been successful in moving girls away from child labor/marriage to education. Given these efforts, the participation of women in higher education has improved considerably. MHRD statistics for 2011-2016 shows that enrolment of females for higher education is reasonably balanced (about 40-45%), and there are significantly more women in science than before (GOI-MHRD, 2016). However, as women

increasingly enter the male dominated bastions, they face biases and barriers, both conscious and unconscious. It is crucial to develop sensitivity towards these issues and provide measures to redress these, in order to attain the ultimate objective of gender equity. Institutions should organize workshops/sessions towards such sensitization. Those that do so, perform well in the overall ethics index. In fact here one is not talking about efforts which are mandated by law and/or funding organizations, but more the measures which Institutes need to take going beyond the legal requirement (Godbole, 2017). Several articles have been written on these issues in India, which provide background, data and suggestions (Malhotra, 2018; Tole and Shashidhra, 2018; Godbole and Ramaswamy, 2012).

Sexual Harassment

The prevalence of sexual harassment in academia cannot be overstated. The 2018 report "Sexual Harassment of Women Climate, Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine" (NASEM, 2018) by the National Academies of Science of the USA describes the results of research into the climate and culture of sexual harassment in academia in that country, which has revealed rather shocking results. For example, a top US university found that '33 percent of undergraduates, 43 percent of graduate students, and 50 percent of medical students experienced sexual harassment from faculty or staff' (NASEM, 2018 page 1). The report concludes (NASEM, 2018 page 117) that "a powerful incentive for change may be missed if sexual harassment is not considered equally important as research misconduct in terms of its effect on the integrity of research".

In India such statistics do not appear to have been researched, and hence the real numbers may be difficult to gauge. For explicit sexual harassment a legislative act in India 'Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013' came into force from December 2013. This statute superseded the Vishakha Guidelines for prevention of sexual harassment at the workplace introduced by the Supreme Court of India in 1997. The Protection of Women against Sexual Harassment at Workplace Bill details the rights of women to complaint, and lays down certain duties for the employer organizations. These include formation of an Internal Complaints Committee with appropriate

composition; to frame policies for sexual harassment cases which will help in prevention, prohibition & redressal of sexual harassment of women at the workplace; to make sure that timely resolution is made for complaints, to provide appropriate legal help if necessary and to publish such data in the annual reports. As alluded to earlier, it is necessary to go beyond the tip of the iceberg when we discuss measures to address sexual harassment in academia.

Promoting Equity and Correcting for Gender-bias

Career Opportunities

It is grossly unethical for an employer to discriminate against a job applicant because of their sex. However, such a bias frequently arises in recruitment processes due to a patriarchal mindset. Doubts about the capability of women candidates to balance their lives and professional careers exist in the mindset of many employers. Scientific institutions are no exception. Questions regarding marital status and commuting distance are common for female candidates, as these are perceived to be counter-productive for 'professional successes'. In many institutions, the provision of campus housing takes care of safety and commuting aspects. However, pregnant women in particular are the worst affected, especially for short term academic appointments such as post-doctoral fellowships. The possibility of pro-actively selecting a woman candidate over an equivalent male candidate is markedly reduced if the woman is known to be pregnant (or even if she is of child-bearing age). Women scientists themselves rarely apply for a post during pregnancy, as they do not find support at home or the work place for a job during that period, and they are socially conditioned towards a career break.

It is observed that when it comes to evaluation of performance in the workplace, differential standards are often applied to men and women performing the same job. Such behavior, however unintentional, results over a long time in the accumulation of advantages for the career of the male over the female academic.

A related issue is representation in the workplace, which is highly skewed, being far lower than the proportion of available candidates. It is problematic that over the last several decades, there seems to be no

significant improvement. Equal opportunity means that one should not deny the opportunity to an eligible person just because that person is a woman. The most effective solution is a positive change of mind-set towards greater sensitivity, which will result in the presence of a larger fraction of women in the academic sector and result in a critical mass of women at important positions. This would lay the ground for environment and attitude change. Currently the community of academic administrators is largely male-dominated and there is an urgent need for pro-active affirmative action to bring equity to all levels of academic community.

Resource Allocations

The equal remuneration act (Web, 1976) is a good example of an act that is implemented faithfully at all public research organizations in India, and women employees are at par with their male counterparts in remuneration. This is certainly a welcome reality. However, the fact that there are fewer women at high-ranking positions as compared to lower-ranked positions is a glaring indicator that for women, promotions do not take place at par. There should be monitoring of compliance to directives issued by the Supreme Court and the Govt. of India that due consideration is being given to any special personal circumstances (such as time away from work on maternity leave and/or for bringing up children) that may have a negative impact on the teaching, research or general contribution by a woman faculty member. The statistics for women award winners in academia are particularly abysmal. It is often the case that male scientists lobby and demand to be nominated for awards and recognition, while female members passively wait to be noticed and nominated. For those exceptional ones who follow the lead of their male colleagues and lobby, there is a general disapproval for such behavior.

While granting agencies have grown more pro-active regarding provision of grants to women applicants, there are many hidden factors that diminish the proportion of women scientists receiving funds for research or travel. Young mothers find it very difficult to attend grant interviews or conferences, as there is no support for child care for at those sites. Often irrespective of their academic achievements, women scientists are left out of various decision-making committees or as speakers in conferences due to their inability to attend such meetings for family reasons. Special care

should be taken by the organizers so that their participation is enhanced significantly. For example, appropriate venues, timing, accommodation, special assistance wherever needed are some desirable measures that can enhance the participation of women.

Representation in Selection/Evaluation Committees

Both career opportunities and resource allocations are dependent on evaluation. A lower percentage of women at the top levels tend to reduce the chances of proper representation of women in the selection and evaluation committees for recruitment, promotion and awards, and this needs to be pro-actively redressed. A bare comparison of bio-data of the candidates listed for evaluation may not reveal the challenging conditions under which these candidates made those achievements. It is anticipated that the presence of a woman may help sensitize committees to such points, resulting in a more informed evaluation.

Facilitating Leadership Roles for Women in the Current Academic Setup

Few women make it to positions of Director/Dean, partly because of an apparent lack of administrative experience. This perhaps arises due to women not being included or avoidance of administrative duties during periods when their children are at crucial stages of education. This does not mean women cannot make competent and even exemplary administrators at a later stage, and it is a good idea to consider a mandatory quota for women in administrative positions. This would compel organizations to find means for filling such quotas. It is important to realize that as long as there does not exist a critical mass of women faculty members who are in decision-making positions, there will inevitably remain a feeling of isolation and alienation among younger women professionals.

Networking and Perception of Roles

Networking with appropriate experts in the field is a prerequisite for recognition and therefore career advancement. Women are generally handicapped in such networking for several reasons. Social forces tend to push women into roles where their aggressive traits are suppressed, and

they are trained that not asserting oneself is a virtue. Academic networks tend to be male dominated and involve bonding of a traditionally masculine nature. Women are often made to experience feelings of guilt about neglecting parental responsibilities, or doubts about whether to be too visible, thereby restricting them from social networking activities. Outreach / counselling programs which help change such social mind-sets are urgently required for both men and women, to highlight the difficulties of the patriarchal system. Even though various women's rights exist and are codified, women are not always aware of them and are frequently hesitant to make an issue of it.

Promoting Work-life Balance

An essential step towards creation of gender equity is creation of an enabling environment for women's progression. This includes promoting changes in the traditional outlook, and being sensitive towards the work environments of women; supporting a work-life balance. In particular, suitable facilities need to be at place for the functioning of a working woman, which are often lacking. This requires creation of facilities within the campus to provide physical assistance, like breast-feeding facilities for young mothers, resting facilities for pregnant women, dedicated child-care facilities where working mothers can keep their children and so on. Lack of such facilities can have serious consequences. Often the compromise solution is to lower one's own expectations and adapt to "reduced career option", thereby compromising one's own potential. Equally important is the creation of facilities to provide psychological assistance, for example, assisting women with questions and problems pertaining to work-life balance, safe working conditions, parenting support and educational needs. As noted above, such facilities should also be available to sensitize men on these issues, which are a collective problem of society and do not simply fall within the woman's "personal" sphere.

These are several relatively simple examples of measures that can be taken to ensure that women are able to comfortably balance their life and work. It is important to make them a matter of priority for institutions, which should support early-stage career-development through the provision of appropriate facilities such as child care and sensitization

regarding paternal responsibilities. It is desirable to work for equitable sharing of parental responsibility and go beyond the concept of career breaks and child-care leave exclusively for women. Women scientists can be enabled to avoid career breaks via provisions for working from home, flexible working hours and so on. Use of modern connectivity tools can help achieve these provisions rather easily. The attendance of women scientists in conferences can be facilitated with special provisions for their needs, such as free accommodation for the accompanying child, and the use of the day-care facility at the venue.

Safety

An important point in achieving the goal of gender equity is ensuring safe working conditions for women. While discussing this issue, it should be kept in mind that the nature of work schedule of an academician working in a University or Institute as researcher, is different from those working in other sectors. This may call for potentially unsafe choices of working schedule such as late working hours, working on holidays and working in isolated environments in a laboratory. In certain types of jobs such situations may be unavoidable, but potential harassment can be prevented when the authorities are vigilant and sensitive. Failure to meet this goal has undesirable consequences. If members of the workforce are anxious regarding safety, they may be inclined to skip work, devote less time at work or even give up the job. On the contrary, ensuring a safe environment is expected to not just make women workers feel secure, but concretely lower the chances of sexual harassment taking place. Women workers who feel assured of being looked after in the event that their safety is threatened will have more confidence and trust in their institutions and will be more productive as a result.

Recommendations

To attract and retain the best talent in Science, Education Research and Governance, it is necessary to make gender equality a part of core values to further the growth of research / technology. It should be recognized that equitable treatment of all members is a constructive approach to creating viable and cooperative academic communities. This includes promoting

full and equal participation of women in all academic activities. The academic environment should be essentially gender-neutral and supportive. Institutions must take proactive steps towards this, beyond the mandated legal ones, to make it clear that there is no tolerance for such misconduct. Specific recommendations are as follows:

i.   Ethical training must be imparted to members, and that should include training of members of both sexes on gender sensitivity. An orientation process, which will make a female employee aware of the existence of ICC and her rights in the workplace, should be chalked out by the organization for women at the time of joining. Attempts should also be made to diffuse power of one person over another of opposite sex, e.g. teacher/ student through setting up of small committees.

ii.   Interview and selection committees as well as project supervisors need to be sensitized about biases. There should be a zero-tolerance policy for offensive comments and behavior. Awareness of diversity issues should be embedded at all levels of decision-making ranging from funding agencies to academic institutions.

iii. The availability of accessible, affordable and high-quality care services must be considered at a high priority. Organizations must strive to provide infrastructure such as campus housing, child-care and other services, lounge facilities to cater to the special needs of women, and provide flexible working times to facilitate maternity and child care needs.

iv.   It is imperative that every organization carries out an annual gender-audit. It would be best if such reports are put up on its web-page. Such public displays of information on gender balance can propel the organizations to become pro-active regarding the recruitment and retention of women employees. Similarly, statistics of drop-out rates of women should be taken. These are probably the best indicators to demonstrate the functioning of exclusionary mechanisms that tend to go unnoticed and unaddressed.

v.   There should be mandatory positions for women academics in selection/evaluation committees as also in decision making groups and leadership roles - both in research and administration. Meetings should be organized in appropriate place and time of the day, so as to optimize inclusion of women members.

vi. While explicit harassment must be dealt with following legal and governmental guidelines, a parallel effort must be made to ensure that such behavior, as well as actions showing bias is seen as strictly unacceptable from an academic and ethical point of view. Orientation of academics in a position of power (Director/Dean/Head) should be put in place, so that they are aware of what constitutes ethical violation in general, and specifically towards sexual harassment.

vii. Funding agencies should continue to support workshops and other activities to promote awareness, diversity and to monitor progress on gender equity.

viii. In terms of regulatory action, complaints about gender bias and harassment may be examined by the Ethics Committee of the concerned institution (over and above the fact that complaints of sexual harassment must necessarily be examined by the Internal Complaints Committee). If it is found that a misconduct has occurred, the Committee shall recommend disciplinary action proportionate to the severity of the offence, as is done for other forms of ethical misconduct. It is essential to demonstrate speedy and effective redressal of complaints, without favor or bias to either side.

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Chapter 9

Recommendations

Kambadur Muralidhar
University of Hyderabad, Hyderabad

Amit Ghosh
National Institute of Cholera & Enteric Diseases, Beliaghata, Kolkata–700010

Ashok Kumar Singhvi
Physical Research Laboratory, Navarangpura, Ahmedabad–380009

> *Ethics is knowing the difference*
> *between what you have a right to do and*
> *what is right to do.*
>
> *—Potter Stewart*

President of the American Association for Advancement of Science, Dr. ED Conklin once said that, 'the ethics of science regards the search for truth as one of the highest duties of man; it regards noble human character as the finest product of evolution; it considers the service of all mankind as the universal good; it teaches that human nature and humane nurture may be improved, that reason may replace unreason, cooperation supplement competition, and the progress of the human race through future ages be promoted by intelligence and goodwill'. All these basically define ethical behavior.

This section summarizes overviews presented in the earlier chapters. A simple tenet of ethical practice is that each person/institution and administrative system works in a fair, honest, unbiased, unprejudiced and accountable manner in their dealings at all levels including, science, administration, publication, relations with their seniors and juniors, financial aspect, academic practices. A simple guiding *leitsatz* in this respect would be that every component places himself on the other side of the table and work according to his anticipations then. In dealing with others, one should not only be honest and transparent but one be obviously so. In

what follows only indicative statements are made as quick recapitulations. These suggestions are by no means exhaustive nor are they meant to be prescriptive. These are indicative and have to be contextualized for each situation.

Ethics in Higher Education

- Quality of teaching in respect of both the technical and ethical content has to be assessed periodically. Structural organization of universities and colleges into departments and centers should reflect the current taxonomy of human knowledge in Natural Sciences.
- Activities and programs of Departments and Centers should reflect the trends of human knowledge growth and hence have to be dynamic.
- Undergraduate degrees should represent consolidative and conceptualized broader domains of knowledge.

The teacher should:
- Adhere to a responsible pattern of conduct and demeanor expected of them by the community;
- Manage their private affairs in a manner consistent with the dignity of the profession;
- Seek to make professional growth continuous through study and research;
- Express free and frank opinion by participation at professional meetings, seminars, conferences etc. towards the contribution of knowledge;
- Maintain active membership of professional organizations and strive to improve education and profession through them;
- Perform their duties in the form of teaching, tutorial, practical and seminar work conscientiously and with dedication;
- Co-operate and assist in carrying out functions relating to the educational responsibilities of the college and the university such as: assisting in appraising applications for admission, advising and counseling students as well as assisting in the conduct of university and college examinations, including supervision, invigilation and evaluation; and

- Participate in extension, co-curricular and extracurricular activities including community service.

Ethics of Research

- The choice of topic for research should best left to the individual scientist as long as he/she operates within the mandate of the Institution.
- Choice of research problem should be decided after careful consideration of all factors and not by 'current fashion' alone. Added dimension of societal relevance may be examined as well.
- While formulating a new research project for seeking funding or for a graduate student, the time-frame, facilities and expertise available for completing the proposed work within the stipulated time-period need to be kept in mind.
- While starting the academic career, research projects that are more or less direct extensions of the work that was carried out during the doctoral and/or post-doctoral research should be avoided. Incremental science has no future and it is unethical to train students in areas without novelty.
- Research projects should be conceived based on originality and innovation and not be based on plagiarized idea of someone else.
- Use of some interesting unpublished ideas learnt as a reviewer or while listening to fellow workers explaining their research, for one's own research, is grossly unethical and should be avoided.
- In experimental research, 'good laboratory practices and documentation be properly followed.
- Wherever relevant, appropriate clearances from institutional and/ or national level ethics committees for the relevant domain must be obtained beforehand when undertaking research.
- The bases of collaboration and credit-sharing should be understood and agreed upon at the initial stages itself as a safeguard against any later stage misunderstanding or dispute.
- The basis for inclusion of specific part/s of the collaborative outcome in the doctoral thesis of a student should be understood and agreed upon by collaborating partners.

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- Use of the concept and/or design submitted by the original investigator without his/her knowledge permission by the facility manager/ provider should be avoided.
- New appointees should be welcomed and facilitated to feel 'at home' by mentors in the institution.
- The doctoral supervisor should be chosen by the student, keeping in view, personal interests and competence of the supervisor in a given field and interest of the graduate student to foster healthy and lasting relationship. Forcing a student to join a specific guide or discipline against his choice is unethical.
- Overly ambitious plan with a large proportion of uncertainty should generally be avoided for PhD level work except in cases of very enthusiastic students who are willing to take up the challenge.
- Research students should be given enough opportunity and training in developing analytical and communication skills, both spoken and written and skills on personal conduct.
- Only the work actually carried out by the student should be included in the doctoral thesis.
- The doctoral thesis should be written by the student with due inputs from the supervisor.
- Research work of doctoral students should generally be published with both the names as authors. Provided, if the supervisor does not wish to be named as an author, the Ph.D. scholar may be formally permitted to publish the work without the supervisor's name.
- It would be unethical for the supervisor to publish the work without the student's name.

Ethics in Measurement Practices

- The research results of a fellow lab mate should not be discussed with other people (especially outside the lab).
- A well-cited protocol should normally be followed, but if for some reason it cannot strictly be adhered to then the "results" obtained should not be rejected out of hand without due analysis and scrutiny.
- In collecting data, as many replicates as possible should be analyzed.
- Over interpretation of the data should be avoided.

- Correct and appropriate statistical analysis of data should be carried out.
- Ethical practices include following safety rules for everybody's safety.
- It is advised to consult the booklet on laboratory safety manual (ACS, 2019)
- It is to be noted that framing lots of new rules has never prevented people from being unethical in any sphere.
- Robust (honest and competent) peer review system at all levels should be nurtured and respected.
- Senior Scientist should serve as credible role models for others to emulate ethical behavior.
- Institutional Review Boards (IRB) at all public and private institutions across all countries proposing to conduct research on human subjects is needed.
- In medical sciences the guidelines of Indian Council of Medical Research (ICMR, 2000) be followed. (http://bic.icmr.org.in/nacscrt/).

Ethics in the Use of Animals

- In the overall interest of both human and animal welfare, animal experimentation cannot be completely abolished at the present stage of our knowledge and development especially in teaching and training. None the less, the guide lines of Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) guidelines have to be strictly followed for research involving use of experimental animals.
- All efforts must be ensured to provide humane care of animals before, during and after the experiments.
- Resources should be provided to upgrade the standard of existing animal houses in scientific and educational institutions.
- All the animal houses need to be registered with CPCSEA.
- Training programmes for all those who are involved in caring for animals and carrying out experiments should be initiated and made compulsory for scientists, research students and other workers.
- All educational institutions should be asked to revise their curricular content with regard to animal experimentation to formulate

alternatives, like use of non-prohibited animal species or better still to utilize non-animal based teaching aids after their careful evaluation/ validation.

• Programmes should be initiated to provide for a mechanism/platform for regular interaction among various stake holders–the Government (CPCSEA), the scientists, the animal welfare groups and the public. The Academy can play a critical role in regard. For more details, kindly consult the INSA publication on animal ethics (Tandon, Muralidhar, and Gupta, 2012)

Ethics in the Use of Human Subjects

• Exhaustive information and guidelines for conducting research involving human subjects have been provided by the Indian Council of Medical Research (ICMR), New Delhi. (https://icmr.nic.in/ ICMR_ Ethical_Guidelines_2017).

• Every institution where social science/experimental research involving human subjects are carried out must have an Institutional ethics committee, constituted as per the ICMR guidelines.

• Rapid emergences of technologies in the area of biomedical research in general and human genome analysis in particular have enabled major discoveries, some with notable translational potential.

• Procedures for genetic testing, genetic manipulation, gene therapy, stem cell mediated therapy and related aspects have been detailed in the National ethical guidelines for biomedical and health research involving human participants (ICMR, 2017) and they should be strictly adhered to.

• Ethical, Legal and Social issues arising thereof must be addressed as per guidelines.

Ethics of Publications

• Authorship is a serious decision and involves consideration of several factors.

• It is mandatory that researchers maintain daily log-books to record every day's work and results. The records should be saved for inspection even years after publication.

- It should be understood that something being freely available on the internet does not mean that it can be copied as such. Due acknowledgement of web resources is an ethical practice.
- The authors must be aware of the issues of data/idea plagiarism and their consequences.
- Authors must follow honesty, objectivity and integrity and avoid bias in experimental design, data analysis, data interpretation, and reporting data, results, methods and procedures in all scientific communications.
- Fabrication, falsification, or misrepresentation of data is plainly unethical and should not be resorted to.
- Trimming outliers from a data set without providing reasons or using an unsuitable statistical technique to enhance the significance of results is unethical.
- Authors should disclose any conflict of interest (personal or financial) that may affect research.
- Researchers should also avoid bias in peer review, personnel decisions, grant writing, grant approval and other aspects of research
- All researchers must keep detailed records of research activities, such as research design and data collection, and correspondence with agencies or journals.
- The authors should be willing to share data, results, ideas, tools, and resources, especially after publication.
- It is the authors' responsibility to honor patents, copyrights, and other forms of intellectual property.
- When privy to someone else's unpublished data/research plans (as a reviewer, editor or a visitor to a lab or member of audience at a lecture, etc.), it ought to be kept in mind that unauthorized use of such data and/or ideas for one's own work is unethical.
- It is mandatory for authors to be honest and objective when complying with journal submission requirements.
- Reuse of published data should follow rules regulating such usage.
- All communication between authors and the journal is to be treated as confidential.

- Authorships like guest authorship, honorary or gift authorship, and ghost authorship should be avoided. These are unethical as they dilute the contributions of real workers.
- A work which is submitted and accepted for publication should not generally be announced to public before its formal appearance.
- Multiple submissions of the same manuscript are unethical. It is unethical, to duplicate or reorganize/reformulate existing publications into new publications by willfully disguising the sources of work. This is unethical.
- Suggesting friends/acquaintances as potential reviewers is also unethical.
- Editors and Peer Reviewers should adhere to the ethical practices while discharging their duties.
- Any conflict of interest in review should be reported to the editor.
- Reviewers should treat all information in the article as confidential.
- Confidentiality of the review process in single- or double-blind system has to be maintained.
- Publication of research output is a societal responsibility and, therefore, should not be taken as a commercial activity.
- Publishing of 'predatory' or bogus journals, which would rapidly publish 'anything' on payment but without peer-review, is absolutely unethical.
- Publishers, editors and reviewers of all scholarly publications have to be vigilant to avoid any possible unethical mis-conduct on their part or on part of authors.

Ethics of Science Governance

- Peer assessment has to be based on both quantitative indices and subjective 'perception' of contribution to domain knowledge.
- Funded research projects should lead to publications of papers in reputed journals, or to patents or to societal benefits like, amelioration of public suffering or improved patient care, or development of some product/process/technology of use for industry or public at large or to findings that can lead to augmentation in yield and quality of crops etc.

- Funding agencies should call for project proposals in the identified thrust areas if they want to ensure social relevance or applicability of the project outcome although Fundamental research, should never be ignored.
- Recruitment and promotion of faculty policies should be transparent to the prospective as well as current faculty.
- Premature communication of research findings, through social media, to public at large should be strictly avoided.
- Peer recognition should precede social recognition.
- It is important to avoid inbreeding as far as possible or feasible, in faculty recruitment.
- Academic structures (departments, centers, mission mode projects etc.) should not be permanent or time invariant.
- In view of constant developments in different branches of science and technology, new schools of study should be established very often.
- As the present-day research is multi-disciplinary, a dynamic model of administration as well as leadership should be encouraged.
- Existing as well as envisaged new centers should follow a clear business model for ensuring viability.

Ethics of Outreach

- Scientists should engage and communicate with other stakeholders in society to generate public awareness and public support regarding science and technology in general, and their area of work in particular.
- Scientists in regulatory roles should express their views in the public interest rather than their own or in the interests of the agencies they represent or examine.
- Scientists should avoid making public claims in the media about their research till it is well established and reliably understood.
- In their media or other outreach interactions, scientists should take care to use language that is objective and professional, and avoid self-aggrandizement.
- Caveats that apply to one's work need to be mentioned, and the contributions of others should be acknowledged, as appropriate.
- Biases and conflicts of interest should be declared.

- The media should be carefully briefed to avoid sensationalizing science and technology reporting.
- The misuse of science for inappropriate advertising and marketing should be strongly discouraged by all stakeholders.

Ethics of Gender Bias

- Gender equality should be part of the core values of every academic institution.
- It should be recognized that equitable treatment of all members is a constructive approach in creating viable and cooperative academic communities. Full and equal participation of women in all academic activities should be promoted.
- Ethical training imparted to members should include training of members of both sexes on gender sensitivity. An orientation process, which will make her aware of the existence of ICC and her rights in the workplace, should be chalked out by the organization for women at the time of joining.
- Interview and selection committees as well as project supervisors need to be sensitized about gender biases.
- Sexual misconduct as well as gender-based harassment in the workplace have to be considered as academic misconduct.
- The availability of accessible, affordable and high-quality care services must be considered an important ingredient in making the environment friendly and safe for women and to create a gender-equitable atmosphere.
- Organizations must strive to provide infrastructure such as campus housing, child-care and other services, lounge facilities to cater to the special needs of women, and provide flexible working hours to facilitate maternity and child care needs.
- It is imperative that every organization carries out an annual gender-audit. It would be best if such reports are put up on the web-page.
- Similarly, statistics of drop-out rates of women should be taken to reveal functioning of exclusionary mechanisms.
- There should be mandatory positions for women academics in the selection/evaluation committees and in the decision making bodies

both in research and administration. They also should be encouraged to assume leadership role.

- Funding agencies should continue to support workshops and other activities to promote diversity and to monitor progress on gender equality.
- In terms of regulatory action, complaints about gender bias and harassment should be examined by the Ethics Committee of the concerned institution and speedy and appropriate disciplinary action initiated.

These are mere guide lines and it is recommended that due diligence by everyone on every act be carried out to ensure the maintenance of highest ethical standards.

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