Original Article
IASR Journal of Humanities and Social Sciences
Website: http://iasrpublication.com/ijhss
ISSN(*online*): 2583-3235

Ethics and STEM Education: the contentions and considerations for the good of society

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A B S T R A C T
Society and man have been plagued with many challenges diseases, that require the integration of knowledge and skills from different science and technology-based fields. From stem cell research to artificial intelligence, many of the most controversial ethical and philosophical dilemmas facing society are tied to science, technology, engineering, and mathematics (STEM) disciplines. This paper explores the concepts of ethics, STEM education, their goals with a view to examine the ethical dilemmas and posited that the consideration for the good of society should be an appropriate guiding principle in matters of ethics and STEM solutions to societal challenges.

Keywords: *Ethics, STEM Education, Contentions, Considerations, Society, Ethical dilemmas .*

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INTRODUCTION

The concept of ethics

The concept of ethics bothers on morals and is fairly difficult to define just in one word. Ethics refers to moral principles that govern how people behaviour, their lifestyle and how they conduct professional activities. The consideration of research with respect to STEM Education is centred on how STEM professionals engage themselves or carry out their professional activities in line with accepted moral principles. Generally, Ethics is the branch of knowledge that deals with moral principles concerned with what is good or bad. According to Rich [1], the approaches to ethics and the meanings of related concepts have varied over time among philosophers and ethicists. For instance, Immanuel Kant an 18th century philosopher and ethicist held that an ideal behaviour was to act in accordance with one's duty and that, well-being meant having the freedom to exercise autonomy and not being used as a means to an end and to have the capability to think rationally. On the other hand, Aristotle, believed that ideal behaviour were practices that lead to the end goal of *eudemonia*, which is synonymous with a high level of happiness or well-being. Generally, and in the context of this paper, ethics refer to moral principles that govern the behaviour of individuals, organisations or society in the conduct of an activity.

STEM Education and its objectives

STEM stands for science, technology, engineering, and mathematics. Each STEM component brings a valuable contribution to a well-rounded education and pervades every part of our lives. Science is everywhere in the world around us. Technology has now become a necessity in every aspect of our lives. Engineering uses the knowledge of science and Technology to design, invent and solve problems in our environment. Mathematics is in every occupation, every activity we do in our lives.

STEM education is a meta-discipline, an integrated effort that removes the traditional barriers between these subjects, and instead focuses on innovation and the applied process of designing solutions to complex contextual problems using current tools and technologies. Kennedy and Odell [2] noted that the current state of STEM education has evolved into a meta-discipline, an integrated effort that removes the traditional barriers between the separate subjects, and instead focuses on innovation and the applied process of designing solution to complex contextual problems using current tools and technologies. Engaging students in high quality STEM education requires programs to include rigorous curriculum, instruction, and assessment, integrate technology and engineering into the science and mathematics curriculum, and also promotes scientific inquiry and the engineering design process. Global challenges such as climate change, overpopulation, resource management, agricultural production, health, biodiversity, and declining energy and water sources need an international approach supported by further development in science and technology to adequately address these challenges [3].

Through better education in ethical deliberation for science students, undergraduate institutions can enable the next generation of scientists to influence society's discussion of ethics. It is thought that by lessening the fear of technology,

bringing first-hand knowledge to the table, eliminating stereotypes, and establishing a deeper way of thinking, a new generation of scientist-ethicists could greatly improve both the discussion and development of ethical policies in science.

Ethical dilemmas and STEM Education

An ethical dilemma is a situation in which a difficult choice has to be made between two courses of action, either of which entails transgressing a moral principle. As science and Technology strive to address many of the challenges such as life and health, security and safety and so on, many more dilemmas related to ethics are created for society to wrestle with. The most prevalent ethical issues in our society are abortion, stem cells, genetic engineering, cloning, super weapons, online privacy, and endless others. All these hinges on society's understanding of science and technology.

Scientists are the foremost authorities on some of the most important questions facing humanity and they must lend their wisdom and understanding to the ethical deliberation process. From stem cell research to artificial intelligence, many of the most controversial ethical and philosophical dilemmas facing society are tied to science, technology, engineering, and mathematics (STEM) disciplines [4]. Stem cells are the body's raw materials — cells from which all other cells with specialized functions are generated. Under the right conditions in the body or a laboratory, stem cells divide to form more cells called daughter cells. Sources of stem cells include embryonic stem cells, adult stem cells and perinatal stem cells from amniotic fluid and umbilical cord blood. Embryonic stem cells are obtained from early-stage embryos — a group of cells that forms when a woman's egg is fertilized with a man's sperm in an in vitro fertilization clinic. Because human embryonic stem cells are extracted from human embryos, several questions and issues have been raised about the ethics of embryonic stem cell research. According to Colman and Burley [5], the origin of embryonic stem cells, such as aborted foetuses, 'left-over' IVF embryos or embryos specially created for the purpose has sparked ethical controversy over, and prompted legislative responses to, stem cell research. In a pluralist society, people hold divergent and deep-seated convictions about the point(s), at which human life begins to have value, and how this value might be respected. Hence the dispute about the morality of the creation and use of embryos in stem cell research. Anti-abortionists and members of the Catholic Church in Europe ardently oppose any research on human embryos because they regard the fertilised oocyte as warranting the same protection as that of adult human beings [6]. Others accord no moral status to embryos at all. Most take the middle ground, according to which embryos assume moral status at a certain age. In the UK, for example, the threshold is 14 days, well after stem cells would be harvested [5]. Kass, cited in Clancy [7] argued that by enabling parents for the first time to predetermine the entire genetic make-up of their children, it would move procreation toward a form of manufacture. It would confound family relations and personal identity; it would create new stresses between parents and offspring. And it might open the door to new eugenics, where parents or society could replicate the genomes of individuals (including themselves) whom they deem to be superior.

In 1997 Dolly the Sheep was the first mammal ever to be cloned. Since that time, the discussion has turned towards the possibilities of cloning human beings either for research ("therapeutic") or reproductive purposes, and even as a potential means for organ farming. Cloning is also known as "somatic cell nuclear transfer" (SCNT), the technical process by which cloning is performed. Cloning is a dominant topic under the broader category of biotechnology. Ethical issues specific to human cloning include: the safety and efficacy of the procedure, cloning for destructive embryonic stem cell research, the effects of reproductive cloning on the child/parent relationship, and the commoditisation of human life as a research product. Kilner and George [8] argued that cloning carries high risks of bodily harm to the child produced through the process. According to them, experiments in the cloning of animals reveal that a high percentage of clones of any mammalian species are born with, or develop, severe deformities or abnormalities. Dolly the sheep, for instance, the most famous of all cloned mammals, was afflicted with a grave premature arthritis. Recently, South Korean cloning researchers have presented compelling evidence to this effect [8].

Ethics and research in STEM Education

Science and the humanities are founded on integrity. It is one of the key principles of good scientific practice and therefore of every piece of research. Only science performed with integrity can ultimately be productive science and lead to new knowledge. On the other hand, a lack of integrity can represent a threat to science, destroying the confidence of researchers in each other and that of the public in science; research is unthinkable without this confidence. According to the Institute of Medicine and National Research Council [9], all researchers have a duty and an obligation to allow integrity to govern their thoughts and actions. It is incumbent on the science system as a whole to grasp and describe the significance and wide-ranging nature of this integrity, to provide the conditions under which it can be enforced and applied and, where necessary, to put in place safeguards against its violation. Only science itself can guarantee good scientific practice, primarily with organizational and procedural regulations.

The conduct of science rests on basic principles valid in all countries and in all scientific disciplines. The first among these is honesty towards oneself and towards others. Honesty is both an ethical principle and the basis for the rules, the details of which differ by discipline, of professional conduct in science, i.e., of good scientific practice. Conveying the

principle of honesty to students and to young scientists and scholars is one of the principal missions of universities. Safeguarding its observance in practice is one of the principal tasks of the self-government of science.

I present here four relevant recommendations made by the German Commission of 'Proposals for Safeguarding Good Scientific Practice'set up in 1997 to develop standards for the conduct of scientific research, following the report of a serious case of scientific misconduct [10].

1. Good Scientific Practice

The recommendation specified the rules and principles of good scientific practice to include:

- the observation of professional standards in carrying out one's research
- accurate documentation of observed results
- questioning of one's own findings consistently in course of the research
- practising strict honesty with regard to the contributions of partners, competitors and previous researchers
- Team working, cooperation and leadership responsibility in working groups
- Deliberate plans for the mentoring of young scholars and scientists
- Clear procedures for securing and storing primary data
- Ways and avenues of disseminating findings through appropriate scientific publications.

It is my view that these rules and principles are germane for the sustainability of ethical scientific practices both in STEM Research and STEM education research and practice.

2. Institutional Rules

The German Commission also advocated that Universities and independent research institutes should involve academic members in the discussion about the rules of good scientific practice. The research community in the university, together with the students need to be involved and to be made aware of the rules of good scientific practice and the consequences of breach to the rules.

It was also advocated that the rules of good research practice should be constituent parts of teaching curricula and of the education of young scientists and scholars in teacher education programmes and schools.

Whilst all Universities in Europe, America and many countries have established ethical procedures and approval for research in all fields, this is yet to be practiced in many universities in Nigeria.

3. Procedure when Scientific Misconduct is Suspected

There is need for universities and research institutes to establish procedures for dealing with allegations of scientific misconduct. It is important that research students and staff in both academic and non-academic departments are made to be aware not only what constitutes academic misconduct, but also, what the procedures are for dealing with allegations of misconducts. The procedures must be approved by the responsible corporate body, taking into account of relevant legal regulations, including the law on disciplinary actions. The procedures should include the following elements:

- a definition of categories of action which seriously deviate from good scientific practice and are held to be scientific misconduct, for instance the fabrication and falsification of data, plagiarism, or breach of confidence as a reviewer or superior,
- jurisdiction, rules of procedure (including rules for the burden of proof), and time limits for inquiries and investigations conducted to ascertain the facts,
- the rights of the involved parties to be heard and to discretion, and rules for the exclusion of conflicts of interest,
- sanctions depending on the seriousness of proven misconduct,
- the jurisdiction for determining sanctions.

4. Authorship

Authors of scientific publications are always jointly responsible for their content. Only those who collaborated meaningfully and significantly made contributions to a scientific publication should be deemed to be authors of the publication. The fraudulent practice where people beg to be 'added' in publications that they contributed nothing should be frowned at, and people found culpable be appropriately sanction.

It is my view that where universities and research institutions uphold and enforce these ethics and standards for good conduct of scientific research, the products of research would be more beneficial for the development of science and society in general.

CONCLUSION

If human cloning turns out to be possible, would it be morally appropriate or acceptable to procreate in this way? If regenerative medicine turns out to be possible, but only by way of destroying human embryos (cloned or uncloned), would it be morally appropriate or acceptable to use nascent human life for this purpose? What do we owe to children? To infertile couples? To patients? What do we owe to the embryo? To society? To ourselves? This paper explores the concepts of ethics, STEM education, their goals with a view to examine the ethical dilemmas and posited that the consideration for the good of society should be an appropriate guiding principle in matters of ethics and STEM solutions to societal challenges.

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