Ethics and STEM Education–The Gap in Nigeria's Education Curriculum

Adolphus, T., Bobmanuel, I. A. and Chukwu, G. A.
Department of Science Education, Faculty of Education, Rivers State University,
Port Harcourt.

ABSTRACT

This article sought to emphasize the importance of "Ethics Inclusion" in the curriculum of STEM Education at all levels in Nigeria. Ethics is a science of character that deals with human judgments and social relationships. If ethnics is incorporated into the curriculum, STEM will be well positioned as a national training ground for responsible and ethical thinking, hence, students will be adequately prepared to engage in ethical decision making, thus contributing to a safe and secured future. Therefore, this paper proposes that Ethics should no longer be kept as a hidden curriculum, but be made a compulsory school subject right from the primary school up to postgraduate level.

Introduction

The word "Ethics" originated from Greek word (ethos), which means "the science of morals". It is a branch of philosophy that deals with the concepts of what is right and what is wrong (Oxford Dictionary, 2020). It defines principles of decent human conduct in life in the various professions and endeavors. Ethics has to do with values, integrity, morals, principles, honesty, rights, fairness, responsibility, conscience, honor, choice etc. It can be used to describe the guiding beliefs or ideals that characterize a nation, community or ideology (Fletcher, 1997). It was first used in the 14th century; history and etymology indicates its image, for example Middle English ethik, from Middle French ethique, from Latin ethice, from Greek ethike, from ethikos (Merriam Webster dictionary 12th edition, 2003). In modern usage, ethos denotes the character, disposition or fundamental values, peculiar to a person, group of people, culture, corporation or movement. Ethos may change in response to new ideas or forces (Arie Kramp, 2010). For example, ideas of economic modernization through oil exploration and exploitation which began in Nigeria in the late 1950s brought about the abandonment of agrarian ethos and the reception of the ethos of rapid development from crude oil revenues.

Morals refer to human behavior where morality is the practical activity and, ethics describes the theoretical, systematic, and rational reflection upon that human behavior (Churchill, 1982). Rennie (2007) stated that values are linked to beliefs and attitudes and they guide human behavior, while the United Nations Educational Scientific and Cultural Organization (1991) affirmed that morals, values, and ethics are strongly attached to society, spirituality and culture. There are three major types of ethics, namely, Deontological, which suggest if an action is good or bad according to a clear set of rules (mostly associated with the German philosopher, Immanuel Kant). Teleological, which has to do with the purpose one's action serves and not the cause or reason for the action (This is called Aristotelian view). Then, we have virtue based ethics, which is the person rather than action based. It looks at the virtue or moral character of

the person carrying out an action, rather than the ethical duties and rules, or the consequences of that particular action.

Ethics and STEM Education

Ethics is a science of character, and is different from natural and factual science. It is a normative science that deals with certain judgments that we make about human conduct (Chowdhury, 2016). Ethics can also be said to be "social relationship which not only tend to ensure the individual's social worth", but also "affords the individual the opportunity to make a meaningful life through his or her contributions to the general welfare" (Amadi, 1982). Hence, ethics may be regarded as the moral principles that govern human behavior, or the conduct of an activity. It has to do with the action of people, either rightly or wrongly. It is a set of moral principles, especially one relating to, or affirming a specified group, field, or form of conduct.

Ethics education refers to all the learning experiences that assist students to develop ethically in terms of awareness and understanding, or greater motivation to act decently in the society. It plays a very vital role in education as it assists in the smooth administration of the system, sets the standard of what is acceptable and what is not, and is also described as moral philosophy. If ethics is introduced as one of those learning experiences that students should pass through under the guidance of the school, it will enable them to prepare themselves for the future as they approach new challenges with open mind and integrity. It will also help students to seek strategies to solve societal problems and practice team-work to put these solutions in place.

STEM Education refers to teaching students in the four disciplines of Science, Technology, Engineering and Mathematics. These four core disciplines have all helped humans to create, imagine and excel in their endeavors. However, STEM Education goes beyond school subjects to a set of skills that governs how people think and behave. In modern society, questions about stem cell research, artificial intelligence (AI), super weapons, online privacy, abortion and bioethical considerations come to mind. The major ethical issues in STEM include ethical dilemmas, health issues, job displacement and gender. As human activity, STEM relates to different human values, hence it is capable of ethic evaluation, both for its consequences, process and action. In the views of Murray and Reiss (2005), the science curriculum should include more ethical and controversial issues which should not be hived off into occasional discrete topics but included throughout the curriculum. According to Raupp (2020), an effective, moralistic approach to ethical STEM Education requires that all stakeholders commit to a framework that:

- Addresses issues of access;
- Promotes the common good;
- Allows for independent thought;
- Commits to equity and inclusion;
- Maintains a free and unbiased flow of ideas;
- Respects the planet and its finite resources;
- Exists unencumbered by commercial demands for profit;
- Insists upon academic honesty and the integrity of research; and
- Provides training to engage ethically with rapidly changing technology.

The Need for Ethical STEM Education in School Curriculum

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UNESCO (2005) stated that "…the study of ethics is important not only for our individual lives but also for developing the insight and competence human beings as a community need in order to face the challenges of the present and future in a reasonably successful way. Many of the most important ethical predicaments the world community is facing today arise in connection with science, in scientific research and in the development and application of new technologies…" Zeidler and Sadler (2008) in their analysis of social and ethical issues in science education asserted that in the classroom setting, contextualizing science learning about real-world controversial issues promotes character development, and knowledge about social and ethical issues in science education. Witz (1996) argued that the current science practicing ideology is strongly acting against the individual's inner moral and spiritual unfolding and fulfillment. Such opposing ideology may restrict an individual from appreciating the goodness and beauty of life and truth. Thus, it cannot provide proper orientation and bases for a sound mind in a sound body that upholds morals and values; which in fact, were historically provided by society, religion, traditional cultural values and moralities.

The non-inclusion of ethical STEM in the curriculum has made schools not to offer courses designed to broaden students' modes of ethical thinking. Consequently, science graduates enter their fields woefully unprepared to further society's understanding of ethics. There is therefore, a serious challenge for the inclusion of STEM ethics in the school curriculum if we must produce students who will be able to shape philosophical discussion. By acknowledging and applying an actionable ethics in STEM education framework, we could go beyond imagining STEM's potential and see tremendous boost to our collective prosperity on a national scale.

Ethical directives are not always clearly evident, and people sometimes disagree about what is right and wrong. These factors lead some people to believe that ethics can be based merely on personal opinion. However, if teachers and students are to enter into the global dialogue of ethics, they must do more than practice ethics based on their personal opinions, their intuition or the unexamined beliefs that are proposed by other people. Therefore, it is important for educators and all stakeholders in curriculum development to be involved in current ethical discussion. The engagement of stakeholders lies in the fact that upholding ethics in STEM education goes beyond what happens in the school and requires others to do their part. An effective moralistic approach would require insistence on academic honesty and integrity of research, commitment to equity, access, justice, inclusion, and training to engage ethically with rapidly changing technology. According to Reiss (2011), there is value in teaching about ethics across the science disciplines both in terms of ethical issues faced by scientists undertaking their work and with reference to the applications to which science is put.

Teachers have the responsibility to teach students morals and behaviors, and act as role models for showing students the desirable characters and traits necessary for effectively functioning in the society. Therefore, to achieve the goals of STEM ethics, teachers require formal training in the styles of thinking and modes of communication necessary for effective contribution to philosophical conversation. Reiss (2011) summed this up in his assessment of ethics in secondary science when he declared that issues such as differences between ethics and science, the demand placed on science teachers, the importance of students' progression, the design of examination questions, the design of mark schemes, and teacher development must be given

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adequate consideration. The inclusion of ethical STEM education in Nigeria's education curriculum will ensure that upon graduation, students will have the knowledge and skills required to work and succeed, as well as the compassion and emotion to be part of a safe, peaceful and cooperative society. For this reason, this paper addresses the need for the inclusion of ethics education in STEM at various levels of education in Nigeria.

Ethics and Disciplinary Issues in Schools

The education sector is a serious one that requires well-defined ethics and values to regulate its operation. It is a well acknowledged fact that school discipline is failing. Canter and Canter (2001) stated that indiscipline is caused by lack of teaching aids/materials in school, peer influence, family, society, poor leadership, lack of justice and realistic regulations. Serious efforts had been made by stakeholders in the education system to curb indiscipline to no avail. Some research had also been conducted on curbing indiscipline such as that of Ali et al (2014), Asiya (2012), Bhan and Gupta (2010), and Freire and Amado (2009) among others. Adeola (2020) reported that the views of Nigerian teachers on strategies for curbing indiscipline centered mainly on the use of reinforcements to promote acceptable behaviors, school authorities being good models, giving moral education in schools, adopting behavioral such as punishment, high parental supervision and referral to appropriate helping personnel, such as counselors etc.

It is obvious that the underlying issue of all disciplinary problems is lack of sound value system. According to Klerk and Rens (2003), the failure to eradicate the problem of lack of discipline include the over-emphasis of individual rights, the negligence of personal responsibility, the lack of fully-fledged public value system to guide learners to think and judge for themselves, and the absence of self-disciplined role models. Consequently, what is necessary in schools is not new policy, more programmes or better projects, but virtuous people who live according to a specific value system. In the views of Chesterton (2019), disciplinary issues in schools can be viewed in two dimensions – the age-old zero tolerance policy vs. give-them-another chance policy. Both policies can be used side-by-side for efficiency in managing moral issues. Zero tolerance policies can be imposed upon aggressive and anti-social and behavioral in-disciplinary actions such as bullying, fighting, stealing, vandalism, examination malpractices, the use of alcohol and tobacco, drug abuse or addiction and possession of dangerous weapons in school. Second-chance policies may apply in cases of conventional school limited violations (mild wrongs) such as attendance, dress codes, eating venues etc., and this can be used to encourage better academic performance and inculcate good behavior and the habit of working hard the next time. However, the opportunities should not be without limit for the same offence by the same person, and giving second-chances should not imply spare-the-rod-and-spoil-the-child attitude. Each of these issues require thorough scrutiny and deep understanding, but even then, there would always be that 'depends upon the situation' factor that would decide which way the verdict rests.

The Importance of Ethics and STEM for Students

Kang & Glassman (2010) see both morality and ethics as part of a way of life and cannot be separated from other aspects of life experiences. Students do not need only knowledge and know-how to succeed, but also emotional intelligence and compassion. Character education focuses on moral concepts, manners and civility, and shapes students' personality, values, attitudes and habits in their development. Neglecting to teach moral values along with academic

concepts will create problems in society and hurt the students. It is normal that a student who has no concept of right and wrong will absorb everything that comes his way like a sponge. Such student will develop poor ethics and no moral values, and will ultimately become a serious threat to society. The incorporation of ethical STEM in the curriculum is important for the following reasons:

1). It will prepare students for their future roles in society. Teaching students moral values in school may determine how they will behave when they become adults. The acquisition of moral values in addition to knowledge will enable students prepare to become good citizens, friends, parents, colleagues and coworkers.

2). Many parents lack the capacity to teach moral values in their homes. As a result, some students are not taught the difference between what is right and wrong by their parents, while some have no parents. Some parents hardly spend time with their children because of busy work schedules, and therefore, fail to serve as role models for their children. Such students copy whatever the society presents to them. The resultant effect is moral decadence in society.

3). Knowledge of STEM learnt in school may be forgotten after some years of graduation, but moral lessons will never be forgotten. This to say that moral values learnt in school will stick with students for life. Teaching moral values in schools will generally instill in students important core, ethical values such as caring, honesty, responsibility, fairness and respect for self and others.

4). Teaching ethics in schools will counter bad influence in society. Some role models people look up to set bad examples such as sexual misconduct, involvement in cult activities, advocacy of violence, condoning of success using dishonest means, drug abuse etc. Teaching of ethics will instill in students the ability to choose what is right and shun what is wrong.

5). Students are exposed to violence, dishonesty and other social vices that are common around them. Teaching ethics in schools will provide an alternative to the violence and dishonesty students see in society. Such unethical conducts include cultism, drug abuse, armed robbery, rape, kidnapping, examination malpractices etc. Teaching moral values in schools will not only reduce these problems, but will enable students imbibe moral values that are based on honesty, modesty, compassion, courage and forgiveness, as well as form positive bonds with other people and become trustworthy and more fulfilling.

Students of business, religion and cultural studies may go through Ethics in Business and Ethics in Religion and Culture classes respectively, but those in STEM often find themselves uniquely immune to the requirements of moral contemplation. For instance, a chemistry student can graduate without ever participating in a class about ethics. The unfortunate result of this lack of ethical education is that neither the ability nor desire to engage in deep ethical discussion is instilled in such graduate. Thus, STEM graduates can enter the workforce without knowing that their involvement in broad ethical discussion is important. Even if they choose to engage in moral discussions, they have no experience in the art of meditative thinking or discourse. Society expects that STEM graduates should lead in discussions of what it means to be human, being the foremost authorities on some of the most important questions facing humanity. Hence, they must lend their wisdom and understanding to the ethical deliberation process. Through better education in ethical deliberation for students, schools can enable the next generation of graduates to influence society's discussion of ethics. By lessening the fear of technology, bringing firsthand knowledge to the table, eliminating stereotypes, and establishing a deeper way

of thinking, a new generation of STEM-ethicists could greatly improve both the discussion and development of ethical policies in STEM. It is therefore evident that ethical STEM education will stand out as a natural training ground for responsible and ethical thinking. Each challenge will afford students the opportunity to engage in ethical decision-making. Making ethical decisions must therefore, be part of their STEM, and later their professional identities.

STEM Education and Ethical Dilemmas

STEM developments have had a major impact on society, and their impact is growing globally. By making life easier, STEM has given man the chance to pursue societal concerns such as education, ethics, aesthetics and justice, as well as creating cultures and improving human conditions. However, there are emerging ethical dilemmas arising from STEM development including job insecurity, data security, crime and terrorism, complexity, privacy concerns, work overload, adaptation to climate change, human animal hybrids, digital media manipulation etc. Consequently, there is urgent need to explore conceptual, ethical and policy issues where science and technology intersect with society from different disciplinary perspectives. This will promote the advancement of science and technology for the common good.

Ethical dilemma refers to a situation where a person is forced to choose between two or more conflicting options, neither of which resolves the situation in a morally acceptable manner. Ethical dilemma takes place in decision-making context where any of the available options requires someone to violate or compromise on their ethical standards. Thus, when dilemmas involve human actions which have moral implications, they are called ethical or moral dilemmas. STEM have a pervasive influence over a number of issues confronting the society. Consequently, ethical STEM should provide the moral framework to guide decision-making and differentiate between right and wrong. For instance, STEM research and development impacts our daily lives in every field, from cell phones, cars, computers and networks and power, and these innovations pose serious moral questions that require honest answers. Such advances no doubt, can drive economic growth, improve agricultural productivity, communication, healthcare and quality of life, and address national priorities. There are however, public concerns about the present and future innovations from STEM research. Arising from such concerns, the John J. Reilly Center for Science and Values puts out some questions about 'Emerging Ethical Dilemmas' which include:

i) What are the benefits of implanting data input/output chips in young children, senior citizens, every day people?
ii) What is the balance between the right to know and privacy rights?
iii) When is it okay to collect data, to provide benefits to the individual? To society? To prevent crimes?
iv) Increasingly, robotics are being used to help those with disabilities. At what point does the interface between body and machine dissolve?
v) Should neuro-stimulation be used to boost motor function, improve memory, and even modify behaviour?
vi) Is internet access a human right? If so, how do w e make use of the precious radio spectrum to close the digital access divide for underserved populations?

Advances in science create new and ever increasing dilemmas for society to wrestle with. "We have been screening about this since February 2014, and people, they've just blocked us out" exclaimed a resident of Flint, Michigan (Jolly, 2015). The issues arising from the lack of ethics training become readily apparent when one considers the number of ethical dilemmas facing society rooted in STEM development. Some of these issues include personalized genetic tests, hacking into electronic devices, driverless zipcars, 3-D printing, adaptation to climate change, and human animal hybrids. More serious still is the fact that research in STEM fields has become much more complex in the twenty-first century. Some research problems are inherently complex in that they raise deep moral dilemmas as could be seen from the questions by John J Reilly Center for Science and Values. Chowning (2005) posited that when students are involved in their own evaluation of an ethical dilemma related to science, they have solid understanding of the science behind the issue. Hence, students need to be trained in essential skills and processes that are crucial for success in academia and beyond. However, this may prove difficult for STEM graduates due to their limited exposure to moral philosophy. Since the task of dealing with moral dilemmas in STEM research requires input from both scientific and philosophical disciplines, it will be difficult for students to respond positively to questions about ethical dilemmas. Consequently, Zeidler et al. (2005) recommended that students should be inspired to learn and practice science for negotiating within and without familiar settings and situations.

In an assessment of ethics and the environment, Ajay and Elaine (2020) opined that the world is confronted with wicked environmental problems that cannot be well understood or acted upon without addressing their ethical dimensions. Therefore, Donovan et al (2014) advocated empowering students through STEM pipeline to assess, preserve, and restore ecosystems in order to reduce ecological degradation and increase economic welfare.

Economic Dilemmas – Job Displacement

Improvements in technology have adversely affected wages and employment through displacement effect, in which robots or other automation complete tasks formerly done by workers. In the 1800s artisans and weavers were displaced by mechanical looms. Toll collectors, bank tellers and even cashiers have also lost job opportunities as technology provides a more efficient approach (Gary, 2016). Unfortunately, many business organizations do not have obligations to displaced workers in such situations, and there are no ethical ways for business leaders to usher their workforces through digital disruptions.

In an article for Market Watch, Satyjit as cited by Gary (2016) wrote: "Technology is taking over the economy and displacing our jobs". This "subsistence existence" he said will come to function if we do not prepare our nation now for the shift in technological employment. As companies embrace automation and artificial intelligence (AI), some jobs will be created or enhanced, but many more are likely to go away. Leprince-Ringuet (2020) affirmed that in the next 10 years, robots will take 50 million jobs. The next five years might see 85 million jobs displaced by new technologies, according to the World Economic Forum (WFF), although the trend could be balanced out by the creation of 97 million new roles – subject, however, to businesses and governments putting in extra efforts to upskill and retain the workforce (Leprince-Ringuet, 2020). Rotman (2017) emphasized that "The economic anxiety over AI and automation is real and should not be dismissed. But there is no reversing technological progress." Atkinson (2017),

Autor (2015) and Bughin et al. (2017) have argued that the many comparative advantages humans have notwithstanding, the scope of full substitution of human jobs by automation is likely to remain bounded, at least for the foreseeable future. It is obvious that as automation technology develops, displacement of workers, demand for newer skills and the continued evolution of work-supplying organizations are inevitable. In the views of Sampath and Khargonekar (2018), humans will and should remain critical and central to the workplace of the future, controlling, complementing and augmenting the strengths of technological solutions. In this scenario, automation, artificial intelligence and related technologies are tools that should be used to better understand the negative repercussions of social cohesion (Mayor, 2019). Undoubtedly, the adoption of technologies that automate human labour has greatly accelerated changes that could threaten the stability of the labour market. However, Rotwell (2013) reported that job growth, employment rates, patenting, wages and exports are all higher in more STEM-based economies. The key point to consider is the implementation of measures that enable everybody to benefit from these transformative technologies. Therefore, the ethics of automation and equality of access for people of different income levels are just a taste of the difficult ethical, legal and policy questions that need to be properly addressed.

Political Dilemma

Some people think that the educational sector ought to be completely shielded from politics, as policymakers are often thought to be dirty, greedy and ready to fulfill their ambitions by whatever means. Contrarily, politics permeates every aspect of human endeavor, including education (Alimba, 2017). Education as a form of governance requires justification, and it entails responsibilities, aims, a way of going about its business, and substance or a communicated content. Based on these factors, Freire (1970) argued that education is political and ethical, and cannot be detached from the current context of social and political realities. This argument is hinged on the policies that govern education, the distribution of educational resources, the pedagogy and the assessments used in classrooms. Chowbury (2016) stated that in the modern era, technology is affecting society in ubiquitous fashion while maintaining its upright position, and both science and technology are also being influenced by society. Thus, the importance of morals, values and ethics in education, and their benefits to society cannot be over emphasized, especially in making political decisions. Freeman Dyson (1979) in his book, "Disturbing the Universe", the American physicist and author, acknowledged that science cannot be separated from the politics of human agency, which in so many cases drives science forward. He further asserted that "We are scientists, second and human beings first. We become politically involved because knowledge implies responsibility". From the research work Dyson suggested that it is the obligation of the scientist (and I would add STEM literate teacher and citizens) to realize that STEM endeavor cannot be separated from a moral conscience. Hence, everyone involved in STEM must endeavor to recognize the dynamics of the interaction between society and science when ethical issues influence how decisions are made (Bobrow, 2015).

John Parrish in his book, 'Paradoxes of Political Ethics' examined the history and philosophical underpinnings of dilemma in public life and concluded that across the centuries significant moral dilemmas arise more frequently within the political arena than they do anywhere else. Undoubtedly, globally, STEM development has received significant moral dilemmas in recent times especially in the areas of Stem Cell Research (SCR), autonomous systems, data collection

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and privacy, human enhancements, depersonalized warfare, social alienation etc. For instance, Christopher Reeve who was famous for playing Superman on the screen and lost the use of all four limbs after a horseback-riding accident in 1995 became an activist supporting human embryonic stem cell (ESC) research (Williams, 2004). In his talk at Yale University, he decried barriers to (ESC) research that he believed had the potential to cure his condition. However, not everyone agreed with Reeve. Ethical, political, and religious concerns have plagued stem cell research since at least 1998, when researchers in Wisconsin derived the first human ESC line. This area of science may not only involve the destruction of human embryos to harvest or test stem cells, but it also raises concerns about such issues as human-animal chimeras, cloning, and donor payment or consent. Yet stem cells hold promise for treating patients with amyotrophic lateral sclerosis, diabetes, spinal injuries like Reeve's, or other devastating conditions. In the views of Staerkle (2015) people lack consistency in their opinions, use information incorrectly, are overconfident in their own choices, fail to adapt existing evaluations in light of new information, draw unwarranted conclusions from insufficient data, and express prejudiced opinions. Since both ethics and politics are concrete fields of public life, whichever field of endeavor, the key point should be about being someone who works with a stable mind and does not allow personal feelings to come into actions. The relation to moral choices should not be about ends and means, but about whether the individual is capable of acting with no personal agenda. Therefore, within the educational framework established by an ethical-political orientation, civic virtues of respectful and reasoned engagement with the views and values of others must be nurtured if a political culture of tolerance and mutual respect is to survive. A good knowledge of political ethics will enable students to cultivate the intellectual and moral virtues essential to good judgment, to nurture capabilities that will provide the basis of lives worth living, and to enable each student to understand the circumstances of his or her own life and the possibilities that lie before him or her. That being the case, students must have access to all sides of given argument to enable them think critically and independently, and also give good judgment.

Conclusion

A child's earliest exposure to morals, values and ethics happens in the family where character first finds its roots. Exposure to culture and learning during school years further shapes the child's ethical outlook. Gerstein (2014), in her post "teaching ethics in the age of technology" writes that teaching ethics in STEM fields is overdue. She explained that ethical decision making should be included as a 21st century skill. Amadi, (1982) recommended that moral instruction (ethics) should be reintroduction into education and made compulsory subject in the schools and universities respectively. The reason for this advocacy is the fact that society and industry are driving the push for students to be creative, innovative, deal with problems and provide answers to problems. However the ability to create, invent and innovate appears to be outpaced by the ability to appropriately manage the technologies. For instance, apart from the prevailing issues of moral decay in society, we have problem dealing with decisions about climate change, food shortages, housing shortages, availability and affordability of medicines, cloning, drones, data chip implants, genetic testing, embryonic stem cell research and many more. The question is: are students adequately prepared ethically to deal with these issues? The answer is no. It is for this reason that Steel et al (2012) declared that STEM disciplines provide

an important canon of knowledge and skills but STEM without ethical grounding remains self-serving and hegemonic. Teachers are therefore, faced with the challenges of helping students to be equipped to make bold decisions based on ethical considerations and responsible conduct.

We believe that if ethics is incorporated into the curriculum, STEM will be well positioned as a natural training ground for responsible and ethical thinking. By this, students will be adequately prepared to engage in ethical decision making. If ethics is included as early as possible in the educational policy of Nigeria, future occurrences of internet fraud and illegal oil refining causing the black sooth been experienced in Rivers State, could be stemmed because through the study of ethics and science, students would have been taught the implications and dangers of practicing science the wrong way. If we must have a safe and secured future, ethical STEM is essential. Therefore, this paper proposes that 'ethics' should no longer be kept as a hidden curriculum, but be made a compulsory school subject right from the primary school to postgraduate level.

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