Article

Epistemic-Based Ethics for Science and Technology: Achieving Sustainable Planetary Wellbeing

Akinpelu A. Oyekunle
https://orcid.org/0000-0002-1697-7233
University of South Africa
eoyekuaa@unisa.ac.za

Abstract

Today's scientific and technological world operates largely with a frontier mentality. The effect of this mentality on modernity, human civilisation and planetary wellbeing is alarming. Just as science aided the development of the modern world, many ecological challenges, ecosystemic destruction and biodiversity loss are also engendered by scientific or technological inventions. Therefore, it is suitable to investigate how science and technology can be hinged firmly on a value-oriented framework, rather than outstripping value in response to its own progressive logic. This article reports on a case study that, among other things, attempted to formulate an ethic of the planetary system. It is argued that such an ethical stance is best encapsulated by the case study's envisioned epistemic-based ethics (EBE). Drawing insights from previous empirical case studies of genetic engineering (GE), the current case study employed the philosophico-phenomenological method to investigate GE. Conceptual clarification and hermeneutical methods were used to re-interpret texts, while the logical reconstruction of existing ideas was employed to aid the development and application of the envisioned EBE framework. Therefore, the article concludes that EBE is a suitable framework for developing science and technological output that has a value-laden stance. Such an attitude would not only assist in making decisions where value-laden questions in technological advancement are concerned, but also guide choices towards a sustainable planetary wellbeing.

Keywords: planetary wellbeing; science; technology; epistemology; ethics; genetic engineering; sustainability

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Introduction

Over the past few decades, the world has seen unprecedented scientific and technological advancements, ranging from molecular biology, nanotechnology and information technology to transforming how society is running (Bibri 2022, 833). These advancements have revolutionised healthcare, education, communication, housing, and many more, leading to an increase in productivity and an improvement in people's standards of living. However, humans are inflicting unsustainable and far-reaching harm on both Earth's natural systems and human fairness, which are essential for future generations' quality of life (Dittmar 2014; Harris 2014; Kanashiro Uehara 2024). The short-term benefit is insignificant compared to the long-term damage, prompting questions about whether future generations will continue to live in an environment suitable for habitation (Oyekunle 2021, 64–73). The answers to these questions depend on how global society chooses to use these significant advancements in science and technology.

Since the publication of Ellul's (1964) work, *The Technological Society*, the philosophy of technology has seen various theoretical, critical and practical approaches to ethics in science and technology (Bibri 2022; Buruk, Ekmekci and Arda 2020; Cenci and Cawthorne 2020b; Gandolfi 2021; Jenkins et al. 2020). Indeed, various efforts have been directed towards the exploration of the ontological, metaphysical, epistemological, ethical, social and political nature and consequences of technology from a Western perspective (Bunge 1966; Ellul 1964; Heidegger 1977; Jonas 1984; Kuhn 1962; Thomas 2024; Vattimo 1993), as well as from a non-Western philosophical orientation (Ansari 2018; 2019; Cruz 2021; Franssen et al. 2016; Hui 2017; Mignolo 2012b; Winner 1986; Young 2018). Nevertheless, an exhaustive synthesis of epistemological and ethical consistency remains unsatisfactory. Thus, the article argues that sustainable planetary wellbeing demands a more systematic ethical framework that is epistemologically based. Such a framework will provide a more practical means to guide scientists, engineers, inventors and entrepreneurs towards contributing positively to the future by avoiding harm, addressing past technological damage, engendering sustainable technological direction changes, and assessing technology's social and environmental impacts.

Human civilisation is transitioning into a global cusp of ecosystem dysfunctionality, where the pressure on planetary limits is of global concern. Such concerns include climate change, environmental degradation occurring at an accelerated pace, and diminishing confidence in a sustainable future. Meanwhile, the rapid evolution of science and technology, even in the optimistic context of global conditions, marks an era of uncertainty. This duality provides opportunities for innovation but also evokes fear regarding the repercussions of technological applications in various fields. Complex fields, such as genetic engineering, nanotechnology, and materials sciences, face a similar dilemma: should people continue to advance cutting-edge research to enhance practice, or should they halt progress until they can reevaluate potential risks?

This article envisions an epistemic-based ethical framework and assessment of near-term guidance of technology and a long-range hope of reshaping technological culture for the broad good of humanity.

Epistemology encompasses the theory of knowledge creation and dissemination (Kelly 2021; Mignolo 2018b; Rowe 2015). Thus, throughout the article, knowledge is taken as a justified evidential body of enquiry in any form, with the notion that epistemic products are encapsulated in the sphere of certainty or reliability. Science and technology are treated as unique epistemological generations serving specific ends, suggesting that epistemology is both descriptive and prescriptive and thus value-laden (Bryant 2011). This implies that value-free scientific methods and the simplistic dichotomy between descriptive and normative theories may be misguided (Bentley 2024; El-Mahassni 2017; Jenkins et al. 2020; Jennings 1983; Kuhn 1962; Proctor 1991; Tsou 2024). Thus, it can be argued that an epistemologically derived understanding of cognitive abilities – such as critical thinking, problem-solving, and value clarification – has implications for understanding and regulating science and technology in many fields. Such an understanding would help individuals and societies navigate the complex landscape of epistemological statements and formations that undergird technological advancements, thereby promoting more informed and responsible decision-making.

Thus, in order to explore the envisioned epistemic-based ethics (EBE) for science and technology, the article progresses in the next section to the intersectionality of planetary wellbeing and sustainable development vis-à-vis the essential role played by science. This emphasises the need for science and technology to shift from short-term, profit-driven goals to ethical, inclusive, and long-term approaches that respect ecological limits and diverse knowledge systems. The next section considers EBE, explores its principle, and argues for EBE as a framework that guides ethical decision-making in science and technology by evaluating knowledge-driven actions through their potential consequences and promoting moral responsibility for the betterment of humanity. This section is followed by an attempt to examine the practical viability of EBE via its application to a case study on GE. The article concludes with an emphasis on the view that EBE provides a framework for aligning scientific and technological progress with sustainable planetary wellbeing via the promotion of responsible, inclusive and democratically informed decision-making processes rooted in ethical knowledge practices. Indeed, by emphasising the integration of long-term sustainability, social perspectives, and interdisciplinary collaboration, EBE encourages innovation of pluriversal orientation, which enhances quality of life without compromising planetary wellbeing.

Epistemology and Ethics

Throughout history, there have been many examples of scientists deciding what is right and wrong for people to know or trying to prove what is and is not the case. During the Enlightenment of the 18th century, orthodox Christianity declined severely, and it was permissible in Britain to speculate against the account of creation and the nature of the universe and its implications regarding scientific enquiry and ethical decision-making (Brown 2002; Hunter 2020). In contrast, questioning church teachings in France could lead to fines or jails (Nash 2020). Kant's (1784) essay, "What Is Enlightenment?" was set to provide a set of criteria for what constituted coming out of the "self-incurred immaturity" that he felt had gripped the people due to the constraints placed upon them by the church and state (Kant and Wood 1996). Thus, setting science on its overbearing trajectory as a decider, a hallmark and a measure of advancement, knowledge, wrongness and rightness.

The word "epistemology" is derived from the Greek words "episteme" (knowledge) and "logos" (theory). It asks what people know; where their knowledge comes from; how it is generated; and under what conditions beliefs are justified or true (Devitt 2021; Kelly 2021; Kung 1995). This is often verifiable, emphasising those factors that identify knowledge as an unadulterated, unquestionable truth (Dolgonosov 2016; Sosa 1995). Ethics is the theories and principles of the set of beliefs about what is moral and what is immoral, right and wrong, and a set of beliefs used to determine the right/correct course of action. Thus, ethics could be said to exist to promote societal wellbeing, with moral individuals advocating what they perceive as moral. (Garrido-Merchán and Lumbreras-Sancho 2023). These definitions offer a wide understanding of the framework that brings about what is perceived to be appropriate within an epistemic community. As such, beliefs are justified and ensure that they are not harmful by integrating ethical considerations into the process of discovering truth and separating functional or positive beliefs for the community or society from those that are worse, negative or non-adaptive (Csató 2022; Nielsen 1987; Outhwaite 1987; Vodonick 2016). As such, beliefs found to be detrimental to the community are considered unjustified given that the action formed by the belief is detrimental.

Epistemology, the philosophical branch of knowledge origination, focuses on conceptual formation, the nature of information, and the justification of beliefs (Andrews 2014; Burlando 2017). It correlates with scientific methods as it is based on gathering information, testing theories, and seeking evidence to justify beliefs. Epistemology is concerned with the justification of beliefs and truths in all areas of life (Andrews 2014; Kästner et al. 2021). For example, the scientific method will be valuable in providing data on the different effects of a drug; while the epistemological method aims to determine the most justified belief about a drug's safety by scrutinising the evidence and its capacity to reveal the truth.

Epistemology and ethics are linked in several ways. Firstly, there are several epistemological concepts which have an evaluative component, namely, reliability, warrant, justification, justification of belief, justification of knowledge, epistemic responsibility and epistemic virtues (Bing and Redish 2012; Devitt 2021; Durán and Formanek 2018; Plantinga 1993). Hence, it accounts for the normative outlook of epistemology. Secondly, ethics as a form of enquiry with implications for action also depends on the truth of some form of realism, which is itself an epistemological position

(Andrews 2014; Garrido-Merchán and Lumbreras-Sancho 2023). Since values and norms exert a profound influence upon enquiry of an epistemological sort, positive epistemology-driven ethics should provide: (1) an explanation of the conditions that allow value-laden enquiry; (2) a logical framework for value-laden enquiries; and (3) a way to measure the success of an enquiry.

Finally, there is considerable scope for evaluating competing ethical positions based on epistemological implications. This raises the issue of whether it is desirable to base the ethics of science and technology on epistemology. However, understanding what constitutes "knowledge"; how it is acquired (Kawall 2010); and how geopolitical and biographical epistemologies work in the face of the global knowledge economy (Mignolo 2018a), emphasises the need for a more inclusive and equitable framework for knowledge production and value-laden decision-making in science and technology. For instance, while accepting multiple ways of knowing, such as experiential knowledge and intuition, alongside empirical evidence could be functional for espousing "socioethical orders" (Cruz 2021), of science and technology; In the same vein, conceiving other epistemic realities based on their ecologies of knowledge and intercultural translation not only challenges traditional knowledge production paradigm but also strikes the need for an intersectional approach to knowledge-making processes in a way that prompts a re-evaluation of the existing ethical paradigms for science and technology (Green 2021; Hui 2017; Santos 2016). Such an inclusive, equitable pluriversal framework for knowledge production resonates with intellectual approaches that challenge and reconfigure how people think about and experience epistemology (Dotson 2012; 2018; El Nabolsy 2025; Hountondji 2009; 2018; Maldonado-Torres 2004; 2012; 2015; Mignolo 2012a; 2013; 2018c).

Sustainable Development, Sustainable Planetary Wellbeing and the Role of Science and Technology

Sustainable development refers to ensuring that a better, higher, enhanced and healthier quality of life is available for all, now and in the future. For instance, the 1992 Earth Summit in Rio de Janeiro, along with Agenda 21, underscored the need for sustainable development to address environmental issues and establish clear connections between the economy, social equity and the environment (Baturo, Dasandi and Mikhaylov 2018; Dittmar 2014; Hba and El Manouar 2018). Sustainable development harmonises the exploitation of resources, the direction of investments, the development of technology, and the arrangement of institutions to meet human needs, with a focus on both the demands of the present generation and those of future generations. Sustainable development is a global concern, encompassing not only the mitigation of issues such as global warming and deforestation, but also the promotion of global practice changes (Eckstein and Melo 2021; Pedercini et al. 2019). Sustainable development aims to address the environmental disasters of past epochs; provide a solace and a brighter future for all life forms; and go beyond retributive actions in response to current global conditions.

The numerous intertwined challenges that act as barriers to global ecological balance and humanity's wellbeing demand a solution that is sustainable and promotes the wellbeing of all existential entities for Earth's systems – a sustainable planetary wellbeing (Kortetmäki et al. 2021; Rockström et al. 2009). The sustainable wellbeing of Earth involves balancing society, economy, and environment to meet people's needs without compromising the ability of future generations to meet their needs in turn. Currently, humans are using resources on Earth at a rate that will make them unavailable to future generations. Maintaining a balance is crucial for an ecologically sustainable society, ensuring the preservation of these resources for the benefit of all (Friend 2019; Zandi 2021). This does not mean that people should not mine resources or change the environment in any way, because many of these changes are inevitable and beneficial. It is important to note that resource use and environmental change do not lead to long-term environmental degradation and risk future benefits from the environment (Dittmar 2014; Manzoor 2018; Riondet et al. 2022; Tomlinson, Torrance and Ripple 2024).

Achieving sustainable development is a complex and multidimensional challenge which involves a broad range of activities and requires a multitude of skills at the individual, community, national and global levels (Harris 2014) Many of such activities revolve around the development and implementation of appropriate policies in areas, such as agriculture, energy, AI use, and trade, among others. Science and technology play a significant role in these activities. and must be developed to safeguard the wellbeing of the planet. Planetary wellbeing is a state in which Earth's life support systems are maintained and the human condition is improving (Kortetmäki et al. 2021). Earth's life support systems are the complex and delicate systems that provide the conditions under which humans and life on Earth have evolved (Aisher and Damodaran 2016; Rolston 2012). The focus on planetary wellbeing contrasts with the use-inspired approach to research and development that provided numerous benefits to the human condition, but has also unwittingly contributed to environmental degradation. Such a use-inspired approach is fuelled by Mumford's (1940; 1964) "frontier" mentality. As such, the focus on planetary wellbeing is a query on the "frontier mentality". To this end, the quest for sustainable planetary wellbeing requires a fundamental shift (Kortetmäki et al. 2021; Likavčan 2024). A shift in approach will require careful analysis of the nature of the problems and the mechanisms by which science and technology contribute to the problems.

In recent decades, a global crisis characterised by pessimism and doomsday symptoms has become increasingly apparent (Bryant 2011; Kortetmäki et al. 2021; O'Briant 1980). Other emerging nations want to escape poverty and achieve industrial-world lives. Science and technology may help maintain progress but they can also contribute to unsustainable habits, making the situation more difficult. The most advanced features of techno-science are knowledge generation and marketing (Gebhart and Funk 2023). Information promotion is a network of individuals with defined roles, who employ strong but dangerous new technologies to produce new and beneficial information. This illustrates the ethical consequences of unsustainable science and technology activities, and highlights the harm caused when knowledge generation is not linked to planetary wellness. To address these ethical concerns, new knowledge-creation approaches that emphasise long-term sustainability over short-term advantages are required. Scientists and policymakers can create a more ethical science and technology sector by shifting the hermeneutic framework from top to bottom Eurocentric epistemic forms to pluriversal knowledge forms (Kaul, Akbulut and Demaria et al. 2022; Kim and Wang 2024; Mignolo 2018b). As well as from profit-driven research to planetary wellbeing (Dittmar 2014; Kanashiro Uehara 2024). A shift to a pluriversal and planetary wellbeing oriented not only demands a fundamental reconfiguration of how knowledge is produced, valued, and applied, but also represents both a critique and a proposition for epistemic justice. This shift requires a thorough examination of the epistemological assumptions and values obtained in the production method, thus showing that EBE highlights the legitimacy of multiple knowledge systems, including indigenous, Afro-diasporic, and non-Western traditions, as coexisting rather than subordinate in the quest for sustainable ethical issues in science (Escobar 2018). The call to a shift to a sustainable and inclusive framework also aligns with the goals of long-term sustainability by embedding scientific and technological practice within relational and holistic worldviews that regard Earth not merely as a resource, but as a living system to be respected and co-thrived with (Kaul, Akbulut and Demaria 2022).

By acknowledging the significance of pluriverse perspectives and diverse knowledge forms, “sustainable knowledge” can be attained (Bryant 2011; Costigan and Pallaris 2012; Weikum et al. 2021). This is because incorporating pluriversality into scientific practice means creating transdisciplinary spaces where dialogue across knowledges can occur—not by assimilating difference into dominant frameworks but by fostering horizontal engagements that resist hierarchy and epistemic extraction (Kim and Wang 2024). It could thus be held that a shift to an inclusive and sustainable framework would decentralise the authority of the Western scientific canon and allow for context-sensitive, locally grounded, and culturally resonant forms of inquiry and application (Santos 2016). For instance, the excessive use of fossil fuels not only contributes to environmental degradation and climate change, but also perpetuates social inequalities and health disparities within and between nations. The latter is mainly because communities of colour and low economic value often bear the brunt of the global ecological crisis (Bryant 2011). According to Grunwald (2004), studies of technological production often overlook sustainability. As such, science and technology can also contribute significantly to the problems associated with sustainability, and hence, the significance of EBE.

An Epistemic-Based Ethics (EBE) Framework

The EBE framework aims to improve moral agency and decision makers within any knowledge-based entity. Players in the technology industry may not be the same as professional ethicists. However, as producers and organisers of scientific knowledge, their work requires attention to achieve sustainable progress in science and technology.

Indeed, an explicit point of EBE is that it is accountable for growing better, improved, healthier, and restored knowledge for the eventual improvement of humanity. EBE, as envisioned in the current case study, holds that one can examine the moral permissibility of a definite motion type (scientific discovery, postulation, or technological innovation) by evaluating it with the aid of a set of feasible alternatives in terms of the potential consequences of such activities, and choosing the best alternative based on a set of so-called resolution principles often translated as a maxim. In the quest for sustainable planetary wellbeing, EBE will be answering the question: "What sort of technological know-how or any other form of expertise is most proper to the improvement of humanity?"

EBE for science and technology is essential for guiding the use and application of technology in a manner that promotes sustainable planetary wellbeing and addresses the complex challenges faced by society. EBE performs this function by examining the fundamental nature of knowledge, its acquisition, and appropriation to inform ethical decision making. The main goal is to ensure that scientific and technological advancements align with the principles of sustainability and planetary wellbeing. Examining the roles of epistemic virtues, such as intellectual humility, open-mindedness, and curiosity, in shaping ethical practices in scientific research and technological development is significant for enhancing sustainable progress. It also promotes the responsible and ethical use of scientific discoveries and technological inventions that can foster a culture of responsible innovation and ethical practices (Andrews 2014; Cenci and Cawthorne 2020b; Vitanov and Ausloos 2011). The next section presents some tentative ideas on an epistemic-based ethical analysis of the main forms and directions of science and technological advancement.

The Four Principles of Epistemic-Based Ethics

Four principles are proposed here for the EBE framework. It is envisioned that these principles will also assist policymakers in translating scientific research into the wellbeing of society and planetary health.

Responsibility

The first principle, enhanced by the EBE framework, is responsibility. EBE studies the epistemic realities that shape the obligation to confront the ethical consequences of the rapid advancement of science and technology. Doing so promotes sustained planetary wellbeing, thereby fostering sustained harmonious coexistence between humanity and the environment. Responsibility is to make "public goods" the inherent interest in the research engagements, innovation or scientific development. By identifying that planetary health and safety is a public good, the responsibility principle activates a precautionary outlook that suggests that technological innovation must take a backseat to health and safety (Tickner, Raffensperger and Myers 2003). Since the EBE framework prioritises collective responsibility through its pluriverse orientation, it will be able to enhance an ethical view of collective responsibility. Thus, EBE strengthens collective moral responsibility by incorporating diverse epistemologies and acknowledging the interconnectedness of all beings (Mignolo 2018c; Santos 2016). Indeed, prioritising preventative science and technology is essential, as science and technology must be aligned with public goods, especially planetary health, as central aims rather than by-products (Cenci and Cawthorne 2020a; Jonas 1984). This cautious view prioritises epistemologically reliable research, which increases public benefits and the quality of life. Given the potential impact of new technologies, this cost-benefit analysis is logical, because precaution is cheap in hindsight and oftentimes, it is the best action in the case of uncertainty; therefore, EBE becomes a conceptual basis for a decision theory of planetary wellbeing.

Research Priority

The second principle, research priority, explains that the persistent question policymakers will ask is: How will this benefit the wellbeing of society and the planet in a specific and direct way? At the heart of the EBE's research priority, a fundamental enquiry for policymakers is: How will this directly and specifically enhance the wellbeing of society and the planet? Central to decision making is the consideration of public versus private goods, the welfare of present and future generations, the assessment of immediate and long-term environmental risks, and the optimal provision of each (Montuschi 2020; Zagzebski 1996). Policymakers must evaluate the trade-offs s between various forms of public goods and determine the allocation of resources for their provision (Rockström et al. 2009). It is the aim of every policy maker to maximise its citizens' standard of living. EBE provides an appropriate framework for exploring these trade-offs and advancing sustainable solutions. The epistemic principles of intellectual humility, open-mindedness and curiosity can help achieve this goal by maximising the provision of specific public goods that will increase the overall standard of living, and as such, help in choosing between immediate economic gain and long-term sustainability (Grunwald 2004; Rockström et al. 2009). The principle of research priority indicates that an increase in the impact of epistemologically credible research correlates with the enhanced provision of public goods, leading to improved standards of living and, ultimately, greater planetary wellbeing.

Transparency

The third principle, transparency, is a fundamental principle that plays a crucial role in fostering trust in the realm of science and technology, as it ensures openness in scientific practices, thus allowing for public scrutiny. As noted earlier, epistemology has in-depth evaluative components, such as intellectual humility, open-mindedness, curiosity and justification. These components allow EBE to objectively assess advances in science and technology by emphasising clarity and reliability in research processes and the disclosure of motivations and assumptions (Goldman 1999). Consequently, transparency in registries stimulates the process of quality improvement in both basic research and novel knowledge and technology production. Transparency determines the blameworthiness or praise of a specific technology. Transparent knowledge systems promote quality control, inform ethical evaluations, and prevent harmful consequences by allowing societies to reflect on past missteps (Douglas 2009; Elliott 2017; Jasanoff 2003). This principle allows for openness towards the assessment of past technologies to uncover valuable lessons for today regarding what leads to unfavourable outcomes for the planet now and in the future.

Accountability

The fourth principle of EBE is aimed at the overall credibility of the values mentioned in all three principles. EBE provides a more realistic means of keeping science and technology accountable, by appropriating the evaluative components of epistemic reliability and warrants. Through epistemic warrants – justified reasons for knowledge claims – EBE advocates for methods and hypotheses that are both rigorous and socially responsive (Plantinga 1993). The accountability principle recognises that the assumptions and presupposed knowledge in any given field is a determinant of what and how research is conducted. It thus suggests that quality and reliable hypothesis specific to an area of interest will lead to an increase assert-ability in the provision of public goods, thus ensuring that ensures that scientific advancements are credible and aligned with collective wellbeing (Durán and Formanek 2018; Oreskes 2019). In doing so, an assessment can be made of the hypothesis to determine the increase in its provision. A justified, reliable and high-quality hypothesis will often provide accurate conclusions in the area of research and interest applied. By fostering a culture of responsibility and research and transparency, accountability ensures that innovations serve the greater good and uphold the values of justice and equity (Durán and Formanek 2018).

Applying the EBE Framework to Science and Technology

The EBE framework illustrates the principles employed to identify the social, environmental and developmental challenges that may emerge from scientific endeavours. One essential way is to apply the EBE framework to answer questions regarding the potential epistemic benefits of adopting a particular scientific methodology or research approach. If there is an inability to address the value of this knowledge or technological advancement and to assure stakeholders – the public – that the knowledge will not be used or applied in ways that are relatively detrimental, then the research should not be proceeded with. If the question can be answered affirmatively, it is a strong indication that the research is justified. However, if at any later point the likely outcomes turn negative, then the research can no longer be considered justified and should be stopped, amended, or shifted (O'Donohue 2013). An example of this is the Human Genome Diversity Project (Kucherov 2018; Rasmussen et al. 2013; Romero et al. 2016), where involved scientists noted that the research was not in the interest of indigenous peoples, despite opposing assertions (Lauter 2023; Tanasescu 2015).

The value of assessing past and present work lies in providing guidance for future work, and on occasion, it can serve to highlight where reparations or amends are necessary. Historically, knowledge has often been regarded as a contingent. It was developed and used at a certain time, and would neither be developed nor used or applied in the same way if the circumstances were different. The present day and future assessments' value can be made, prepared and applied using the methods stated above. If it was found that at no point was the knowledge in line with the best interests of global stakeholders, it is knowledge which is best forgotten. If otherwise, in the interests of the planet and its stakeholders, the knowledge can be developed and used in a manner deemed relatively beneficial. This was suggested for the Human Genome Project (which operated from 1990 to 2003 and provided researchers with basic information about the genetic content of the human organism) because of concerns regarding its potential applications (Cutter 2023; Gisler, Sornette and Woodard 2010). To establish a clearer understanding of the application of the EBE framework to science and technology, let us examine some issues in science and technology in the next section. It is hoped that a look into the case studies will help in understanding how EBE could be employed to interrogate some of the challenges and ethical dilemmas faced by science and technology.

Case Study

The issue of genetic engineering (GE) and ethical dilemmas regarding modern and future generations will be the focus here. It seems relevant to choose this example because it allows researchers to gain insight into the potential consequences and impacts of GE on modern and future generations, both humans and non-humans, in terms of planetary wellbeing. GE stems from the technology connected with sequencing the human genome, to understand its causes and helps to cure disease illnesses (Bartley et al. 2020; Popova and Carabetta 2024; Wu 2020). An example is the recent discovery of the genes responsible for high cholesterol levels and several types of cancer (Bulletin Board 2008; Chen et al. 2021; Lu et al. 2025). This discovery is expected to aid medical researchers in finding a cure for these diseases. However, the research and the discovery it engenders raised many ethical questions and socio-cultural dilemmas. One of the major dilemmas is whether re-engineering human DNA would involve the near-moral dilemma of tampering with humanity: God's creation. This raises concerns about the consequences it would have on human health and the moral limits of tampering with human genetic composition.

GE has the potential to enhance species by engineering humans with the strength of a gorilla or the eyesight of an eagle. Nonetheless, the potential cost could also be the essence of humanity. In a society where access to an "improved" genotype is limited to the affluent, significant pressure would exist to avoid conceiving "unimproved" children. Furthermore, the concept of "improvement" would probably reflect the values of the power-holding class (Cohen 2015; Fromhage and Jennions 2019; Joly 2011). With a limited number of exceptions, the traits that can be engineered are those that already have a genetic basis. Nonetheless, there are many other traits that make humanity a rich and diverse product of genotype and life experiences. GE threatens to reduce these diversities by making genes the primary determinant of whether and how the human qualities to which it correlates manifest. Such a perspective on genetics undermines the complexity of the interaction between genetics and the environment and neglects the strong influences of development and socialisation on the expression of these traits.

The current case study is one of rich philosophical issues beyond safety concerns, for which there is vast literature on bioethics (see, e.g., Boezak 2017; Mittelstadt 2019; Musser 2020). One such safety concern is the issue of the self and personal identity. Genes are the master control system of all living organisms, and if genes are changed, then individuals' biological selves are changed. However, it is a widespread view that the body is different from the true self or the house in which the self lives, something like a car that can be driven or discarded, a translation of the soul (Nuzzo 2013). In some cultures of the world, it is widely held that an individual's essence transcends their physical body (Broadie 2001; Martins 2018; Mokoena 2025). As such, the spirit is considered powerful and capable of overcoming any physical limitation (Pedersen 2024; Vidal 2013). However, the modification of genetic material undermines these beliefs. In addition, the creation of a re-engineered organism entails inherent risks because human genetic re-engineering may result in individuals lacking awareness of their identity, necessitating a search for self-definition. This would result in the formation of a subhuman caste characterised by a lack of wholesomeness, moral suitability, and social enhancement for self-improvement.

Additionally, a fundamental social controversy related to the challenges posed by GE is the question of who is entitled to determine the extent to which human genetic material is to be altered. Is it a call by a single individual or the population as a whole? On the one hand, autonomy's proponents might opine that it is possible to imagine that a person has the right to feel empowered concerning their genetic identity and the outer forces crossing these boundaries represent the invasion on the right to choose under which flag they are marching (Cohen 2015; Cutter 2023; Ma, Li and Zhang 2020). Individuals should assert complete autonomy over the determination of their genetic identity, free from societal and external influences or norms which are essential for the preservation of future generations. Nonetheless, an opposing viewpoint posits that the autonomy of choice has many consequences that have nothing to do with an individual but would touch upon the entire society. Proponents of societal focus thus contend that autonomy is not supposed to include the personal decisions concerning matters that touch upon the responsibility to choose society's common identity (De Cristofaro 2013; Naveed et al. 2014).

Advocates of a society-focused approach argue that the collaborative decision-making inherent in this method would yield informed decisions by integrating diverse perspectives and ethical considerations relevant to contemporary challenges and potential risks. Since these proponents suggest that bio-engineered products will become a reality, a more comprehensive and holistic approach is required to ensure that these actions are safe and ethical and may apply in current generations while simultaneously considering future generations. This is achieved by transforming their orientations from individual rights and responsibilities to a collective scenario regarding shared responsibilities in the domain of GE (De Cristofaro 2013). Here, EBE is applied as it offers decision-making perspectives based on rationale, evidence and systematic approaches. This approach provides ways to tackle the ethical issues involved in the integration of scientific knowledge, societal concerns and ethical choices based on informed decisions. The EBE framework provides a systematic approach to decision making by integrating scientific, humanistic, and ethical considerations, thereby promoting a sustainable and responsible future. The implementation of EBE in GE offers the potential for future advancements. These advancements will be ethically utilised to ensure the wellbeing of both current and future generations.

The current case study demonstrates the evidentiary value of EBE in research and technology. Some of these include enabling scientists and technologists to consider the potential risks and returns of their research through a single objective: the sustainability of planetary wellbeing. Using this technique, scientists should make informed long-term decisions, prioritise environmental resource preservation, and contribute to the overall health of the world. In employing EBE, scientists and technologists can also consider the sociocultural impacts of their research and development on GE, which could be achieved holistically in the context of planetary wellbeing.

Since scientific and non-scientific fields are interconnected and incentives differ, an epistemic-based ethical paradigm encourages scientists and technologists to work together. At every level, the EBE framework requires scientists and technologists to actively engage with the public, policymakers and stakeholders to ensure that research and advanced technologies reflect society’s highest value for human efforts and the planet’s sustainability. Like EBE’s ideals, this connection concerns transparency and accountability. This explanation shows how science and technology can be used to help future generations build sustainable societies.

Analysing science’s epistemic base may reveal how diverse means of acquiring knowledge contribute to human rights. These awareness levels will help researchers and politicians to justify policies and practices that preserve human rights. Therefore, understanding the dynamic relationship between epistemology and ethics is crucial in defining scientific and technological progress. This dynamic interaction helps to develop rapport when scientific inclinations collide with environmental and social perspectives and boost social responsibility. In turn, social responsibility promotes ethical science and technology decision making. Humanity’s goodness on Earth evolves and becomes more efficient when ethical issues related to scientific advancement and technology are identified and addressed.

Conclusion

The current case study examined how EBE can improve planetary wellbeing. The article has discussed how sustainable knowledge determines what to do and when to meet existing needs, without sacrificing the future for planetary welfare. The case study proposed that sustainability and quality of life are common goods. Pursuing quality of life creates win-win connections. Interactions that benefit both parties are win-win. Sustainability improves living standards for all organisms on Earth, without unlawfully exploiting the environment.

An epistemologically sound view of knowledge, its justificatory processes, and its purposes and ideals illuminate current faults in science and technology and is a way to reform. Scientists and technologists may concentrate on sustainable planetary health by adopting epistemic-based ethical conduct and attitudes. In turn, EBE requires the redesigning of science and technology to ensure human and biospheric survival and growth. Thus, EBE might help science and technology solve the current accumulation of applied challenges by generating critically constructive research and creativity, and being responsible for product use.

The quest for sustainable global wellness may be integrated into EBE, as shown in the case study. Since the EBE framework combines ethical concepts into scientific and technical decisions, it promotes long-term planetary wellbeing while being humane. It also supports responsible innovation that considers the long-term effects on humankind and the world, making it more important for sustained planetary welfare. The EBE framework recognises the link between scientific and technological advancement and environmental welfare, which guarantees that scientists and technicians evaluate the consequences of their work and challenge morality. Thus, it may encourage more responsible actions based on knowledge of the complicated links between humans, nature, and future generations.

Furthermore, the proposed framework promotes multidisciplinary collaboration, as it integrates different disciplines while acknowledging that sustainable planetary wellbeing is a complex problem best resolved through the collaboration of various experts and fields. Indeed, EBE contributes significantly to the vista of studies that border the development of science and technological output with a value-laden stance. Finally, EBE enhances integrating social perspectives in the making of scientific decisions guarantees that they are made democratically, as evidenced by the participation of all stakeholders with a pluriversal orientation that enhances inclusivity in decision making. As such, EBE has the potential to facilitate sound decision-making regarding value-laden questions in technological advancement and guide choices towards sustainable planetary wellbeing.

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