ARTIFICIAL INTELLIGENCE AND THE TRANSFORMATION OF KNOWLEDGE ACQUISITION IN SCIENCE EDUCATION: AN EPISTEMOLOGICAL ANALYSIS

By UWAKWE, ANTHONY CHIEMERIE

Department Of Philosophy, Faculty of Art's
Alex Ekwueme Federal University, Ndufu-Alike Ebonyi State, Nigeria
Email: uwakwechiemerie2020@gmail.com; 09010803113

Abstract

The emergence of artificial intelligence has created an impact on the way knowledge is gathered and disseminated in the domain of science education. This paper focuses on the epistemological analysis of artificial intelligence that is transforming the dynamics of science teaching and learning. The paper addressed the increasing conflict between traditional approaches of gathering knowledge, which are usually teacher-centered and focused on content, and artificial intelligence-based learning systems that are dynamic and responsive to learners. The aim of this work is to analyse artificial intelligence in science education and its impact on knowledge acquisition. With the following objectives: Examining how artificial intelligence affects knowledge acquisition and justification; Evaluating the changing roles of instructors and learners within Ai-Supported Environment; and to know whether artificial intelligence improves or hinders scientific knowledge. This research is important in the sense that it provides the curriculum designers and educators an approach in evaluating not only the knowledge acquired by the learners through AI, but how the learners interpret the acquired knowledge. This research has raised some questions: What is knowledge in the age of Artificial Intelligence?, Is information produced by AI considered real knowledge?, What is the difference between information, knowledge, understanding, and wisdom?, How does AI alter the traditional relation between the knower and the known?, How should scientific knowledge produced by AI be validated and justified?, Does the reliance on AI enhance or diminish critical thinking and epistemic agency of students?, and What becomes of the traditional function of the teacher as a circulator of knowledge?. These questions are fundamentally epistemological in Analysing information and the authenticity of knowledge. This work adopt qualitative approach which different articles, books, and journals were used in conducting this research. Using Analytical and dialectical methods. These methods are appropriate in carrying out the research because, it examines and clarifies concepts such as AI, knowledge, epistemology, learning, truth, justification, and scientific knowledge. And also questions information to discover the authentic knowledge. In Analysing the epistemological consequences of artificial intelligence in science education, it is evident that there is potential for transforming knowledge acquisition and dissemination into something, innovative, interactive and personal. Artificial intelligence holds great promise for science education, however, it should be implemented with philosophical wisdom.

Keywords: Artificial Intelligence (AI), Science Education, Knowledge Acquisition, Epistemology, Teaching and Learning Dynamics, AI-mediated Learning, Critical Thinking

Introduction

Knowledge acquisition has historically been an integral part of educational theory and practice. Education should not be equated to the process of information transfer from a teacher to the student but should include all the processes that people go through in encountring information, analysing the evidence, building their understanding of it, and validating what can be considered knowledge. This processes takes a greater significance in science education, because the knowledge produced in that field should be based on observation, experiments, reasoning, evidence, critical thinking, and the testing of claims. The question of what people know and how people come to know things has been an important one in the modern education despite the new context for the production and acquisition of knowledge. The traditional epistemological problem of what knowledge is, how it is gained, and how its validity should be tested has been the main topic in classical philosophy.

The use of artificial intelligence (AI) in science education has drawn great attention recently. Since ancient empiricism up to the latest epistemological theory, epistemology has presumed knowledge to be an exclusively human attribute based on observation, logic, and communal intellectual tradition. Artificial Intelligence has made its way into the domain of education. Private sectors have begun developing 'intelligent' , 'adaptive' and 'personalised' learning platforms that will be used in schools and universities around the world in the coming years (Bhutani and Wadhwani, 2018). Undoubtedly, use of AI in education brings with it many important questions such as what ought to be taught and how, changing roles of teachers and AI's socio-ethical considerations.

However, the fast-growing popularity of artificial intelligence (AI) in education,including issues such as educational equity and access, technology has started to challenge this centuries-old assumption. The activities formerly carried out by humans solely have been increasingly substituted for technological operations. This development has raised numerous concerns about not only education but the nature of knowledge altogether. We consider ourselves to be Homo sapiens—man the wise—because intelligence is such an essential part of our existence. For millennia, we have been trying to make sense of the way we think and behave, i.e., how the tiny organ in our head manages to sense, comprehend, and even predict and manipulate its world, which is much bigger and more complex than it.

In the last five years, owing to some notable successes and disruptive capabilities, artificial intelligence (AI) has moved from the backwaters of scientific research to the forefront conversations, such as those that take place at the level of the United Nations. In many countries, the use of AI is on transformation in everyday life – from personal assistants on smart phones to customer service chatbots, from recommendation of entertainment to prediction of crimes, from facial recognition to medical diagnoses (Miao et al., 2021).

The science of artificial intelligence, or AI, however, is not only interested in the study of intelligence but also in its creation as well. More specifically, artificial intelligence tries to design machines that can calculate the best course of action for any situation. Surveys often list AI among the most exciting and rapidly developing sciences, and it is expected to earn a trillion dollars per year. Kai-Fu Lee, an AI expert, thinks that it will change our lives “more than anything in the history of mankind.” Moreover, the intellectual boundaries of AI are almost limitless (Russell & Norvig, 2020).

The construction of knowledge in the context of scientific learning was always considered an ongoing process that depended on observing and experimenting, as well as critical reflection. Students were encouraged to participate actively in their learning of scientific principles through guided teaching and experiential learning. However, the introduction of AI technology, from intelligent tutoring systems to generative AI systems, has changed this process completely. The use of AI systems has gone beyond that of simple tools that provide access to information. These systems influence the knowledge-creation process as well as its validation and dissemination within the field of education. As one recent scholar observes, the use of AI involves “knowledge sources based on algorithms”that challenge traditional mechanisms of epistemic authority and verification (Nurnaningsih et al., 2024). Such transformation begs for an epistemological examination.

The traditional definition of knowledge involves factors like truth, beliefs, and justification. But AI creates complexities in these elements. AI is able to give out outputs that are valid and accurate in their contexts but do not have direct processes of justification that human knowers can examine. According to Simbolon et al., even if AI fulfills external requirements like reliability, it often falls short of internalist standards of self-consciousnes (Simbolon et al., 2025). Thus, one could wonder whether AI knows anything at all or is just mimicking knowledge that changes human perceptions. The difference between information and knowledge becomes especially important in this case. Information is quickly accessible, while knowledge requires interpretation, justification, coherence, and understanding. The importance of this phenomenon from the philosophical point of view is that AI is likely to change not only the way knowledge is acquired but also the way knowledge is interpreted. When a student asks an AI program to define truth, describe photosynthesis, find the solution to a chemical equation, interpret biological processes, and analyse a physics problem, the student is dealing not only with a textbook, a teacher, a laboratory, or a fellow student anymore. The student is dealing with a computer program that produces an answer based on the pattern extracted from big data sets. In this way, an epistemological intermediary appears, whose credibility needs to be questioned. Hence, the student is required to ask himself/herself such questions: Where does this answer come from?, What arguments support it?, Is the answer scientifically valid?, What assumptions does this answer contain? ,Can this answer be verified independently?. Such questions are of high relevance in science education because scientific literacy requires not only memorisation of information. It requires the ability to critically assess claims, understand scientific reasoning, and recognise uncertainties.

The gaining of scientific knowledge was very much dependent on observation, experiments, reading of textbooks, libraries, lab works, as well as the dialogue between the teacher and the student. The teacher was often seen as the main mediator of knowledge, but the student had to engage with the existing body of knowledge through pedagogy and self-study. Nevertheless, the advent of digital technologies gradually changed the situation. The Internet, digital libraries, online databases, educational portals, simulations, virtual labs, and other means of educational technologies opened new possibilities for the interaction of students with knowledge. Generative artificial intelligence technologies increased the importance of this trend. Systems that were able to generate human-like texts, images, computer code, explanations, and many other kinds of content became widely available to both students and teachers. In science education, they could be used by students for comprehension of complex notions, creation of hypotheses, obtaining explanations immediately, searching for other ways of solving scientific problems, and other purposes. The epistemological issue in regard to generative AI become more complex. While search engines merely refer users to other materials, generative AI can actually generate answers that seem original. This may lead to what one could call an illusion of knowledge. The learner gets a fluent and coherent answer, and so believes that the answer must be true. However, while fluency does not equal truth, neither does accessibility equal justification.

For UNESCO, the recommendation concerning the use of generative AI for education and research implies that a human-centred approach should be adopted in order to answer privacy-related issues, ethical validation, pedagogical considerations, questions of equality, and meaningful use (Miao and Holmes, 2021). Another issue related to the use of generative AI is epistemic reliability. AI programs produce false statements or misleading pieces of information in a way that makes them look reliable. Thus, the question arises about how students can determine whether an AI-produced piece of information is reliable. Recent research devoted to the attitudes of science teachers towards generative AI has also emphasised the issue of the changing status of knowledge in light of generative AI and its implications for science classrooms (Garofalo & Farenga, 2025).

The use of AI in education has transformed many aspects of the education system such as teaching methods, assessment techniques, and administrative processes. At the same time, the adoption of AI is a dynamic force behind the development of science education. This systematic review strives to offer an inherent understanding of the evidence-based relationship between AI and science education. However, the development of AI in science education entails a vital epistemological question: How does the meaning of knowledge acquisition change when learners rely on intelligent computational systems to acquire, interpret, and produce knowledge? How does artificial intelligence reshape the process of knowledge acquisition in science education? In what ways does AI influence the nature of scientific knowledge (e.g., objectivity, validity, and reliability)?,Does the use of AI tools shift learners from active knowers to dependent users of generated knowledge?, and How can traditional epistemological frameworks be reconciled with AI-driven knowledge systems?.. These are the concerning questions that this research is based on. The AI technology could give the learner the correct scientific answer, without the learner knowing the logic behind it, the evidence on which it is based or even the ability to evaluate its truth.

The significance of the current study thus emerges from its effort to move away from the question of whether artificial intelligence is either good or bad for education. Artificial intelligence is neither intrinsically educational nor destructive; the epistemic ramifications of AI rest upon its design, access, interpretation, regulation, and use within educational contexts. For Science education, the current study offers a much-needed theoretical framework for incorporating artificial intelligence while not compromising the core values of science. For Students, it will allow them to be aware of the distinction between information produced through AI and information that has been analyzed and justified. For Teachers, there is an increasing need for teachers to guide their students in assessing AIproduced information and instilling responsible research practices in them. For Nigeria and Africa, The study is very relevant for Nigeria and Africa considering the technological changes that are taking place on the continent along with inequalities in education. Finally, this study is significant for epistemological discourse of the present era since it explores the shifting borders between human and technological agency in the construction of knowledge.

It is necessary that students must also be capable of acquiring new forms of epistemic literacy, which are the skills that allow one to Analyse the credibility, biases, and limits of the knowledge generated by AI. Otherwise, there will be a possibility that students will merely become consumers of the answers produced by algorithms instead of becoming co-producers of scientific knowledge. the emergence of AI indicates a move from an approach to knowledge formation that is exclusively human-oriented towards one where knowledge formation is a joint effort between humans and machines. While in past epistemologies, knowledge was formed through human intelligence and intellect, today, AI systems can operate independently to analyse huge volumes of data, detect patterns within them, and produce new knowledge. Thus, AI takes part in the creation of knowledge and its validation (Shang et al., 2025).

Materials used on this research were sourced from articles, books and journals and Qualitative philosophical research approach is used in the study, relying primarily on Analytical and Dialectical Methods, because, it examines and clarifies concepts such as AI, knowledge, epistemology, learning, truth, justification, and scientific knowledge. And also questions information to discover the authentic knowledge. The main concern should therefore be how to use AI in such a way that it does not undermines the learner's capacity for independent thinking and judgment. The epistemological revolution created by the introduction of artificial intelligence is not only technological but philosophical. This means that it makes us rethink some basic questions relating to what is meant by the concept of truth, who has epistemic power, and knowledge versus understanding.

Conceptual Clarification

The relationship between artificial intelligence, knowledge and education involves concepts which provide the backbone for this research. Artificial intelligence is not merely an educational tool while knowledge acquisition cannot be defined as mere information retrieval. Likewise, science education is not only about teaching of scientific facts but also it involves developing the skills of inquiry, reasoning, evidence based decision making, experimentation and reflective thinking. As the current research is centered on artificial intelligence from an epistemological perspective, it becomes necessary to define the key concepts which make up its intellectual core. Key concepts which have been defined include; Artificial intelligence, knowledge, knowledge acquisition, science education, epistemology, and epistemic agency.

The Concept of Artificial Intelligence.

Defining AI is not easy, there is no agreed upon definition of artificial intelligence; rather, there are variety of possible definitions that make things confusing. Definitions of AI will be covered first in order to reveal why the chosen definition is appropriate. AI is the imitation of human intelligence carried out by computers. Purists points out that many existing applications are too simplistic to be considered artificial intelligence; thus, this definition is not suitable for our report. Using this definition, we will be saying that artificial intelligence does not exist at present. Artificial intelligence can be defined as the technology that allows machines to imitate various complex human skills (Prins et al., 2023). Nevertheless, this does not help us much. This is because all we get is a restatement of the term 'artificial intelligence'. It is impossible to know what AI is until 'various complex human skills' are identified. It is no surprise that it is so hard to define AI. It is because AI imitate something that is not completely understood by us yet: human intelligence. It has been a subject researched by psychologists, philosophers, behavioral scientists, and neurologists among other researchers for years. To understand the basic concept of AI, it is the use of computational processes to enable computer systems perform functions related to human intelligence. They include learning, reasoning, problem solving, perception, language, decision making and content creation.

The origins of AI can be attributed to the advancement of modern computing and the philosophical question of whether machines can demonstrate intelligent behavior. Alan Turing posed the famous question, "Can machines think?", which redirected the attention from being concerned with the concept of intelligence to being concerned with the behavior of the machine. In his seminal essay, he introduced the imitation game as a possible method of determining whether a machine can imitate a human being in some circumstances (Turing,1950). What was so important about Turing's contribution in AI is not just the history of AI but the philosophical issue it presents: if a machine can produce intelligent responses, what exactly distinguishes human intelligence from artificial intelligence?.

The term 'Artificial Intelligence' was formally introduced into academic discourse through the Dartmouth proposal made by John McCarthy and other researchers in 1955. The proposal was based on the assumption that the aspects of learning and intelligence would be adequately described such that the machines would imitate them (McCarthy et al, 1955). The emergence of AI initially involved the use of symbolic and rule-based approach in programming machines to perform operations using symbols. Machine learning subsequently changed this approach to some extent. Instead of being instructed completely, machine learning involved systems which could Identify patterns from data and get better with time through practice. This gave rise to a major difference in the relationship between humans and computational machines. While in traditional programming, the humans give the rules and machines follow them, in machine learning, the machines are able to find out patterns from huge amounts of data which makes the output generation process difficult for the average user to comprehend. The development of deep learning and neural networks further expanded the capabilities of AI .Today, AI systems are used in areas ranging from medicine and finance to transportation, scientific research, education, and communication. The emergence of generative AI represents a particularly important development for education because such systems can generate text, explanations, images, computer code, and other forms of content in response to human prompts. In an epistemological sense, the significant of AI technology lies in the fact that it finds itself between the learner and the subject of knowledge. The learner is no longer directly accessing knowledge when he/she poses questions to the AI system on subjects such as Newton's Laws, chemical reactions, mathematical equations, and biological processes. Rather, what the learner gets is a technologically mediated knowledge about the matter in question.

The Concept of knowledge:

One of the most basic philosophical notions is the notion of knowledge. Despite the absence of any universal definition of knowledge, the traditional classical epistemology tends to distinguish knowledge from opinion, belief, or information. According to the classical definition, the concept of knowledge is defined as "justified true belief," even though modern epistemology showed that such definition is not enough to describe the concept of knowledge in all its manifestations. The distinction between knowledge and belief is especially applicable to the sphere of AI-based learning. A student may believe an answer provided by an AI program without having the knowledge of the subject in question. Any claim cannot be considered knowledge if it does not have any justification and can survive any criticism. This is particularly important in science, where claims are expected to be supported by evidence, rational explanation, observation, and reproducibility.

The pragmatist notion of knowledge presented by John Dewey is a good starting point for the study of scientific learning. According to Dewey, inquiry is not the acceptance of known facts but the activity of exploring and solving a problem (Dewey 1938). In his *Logic: The Theory of Inquiry,* Dewey claims that inquiry entails the change of an indeterminate situation into a determinate one through investigation. This idea of knowledge has serious consequences for the use of AI. On the one hand, a student who uses AI in order to get a ready-made answer without asking questions, investigating, experimenting, and thinking, receives some information but does not gain knowledge. On the other hand, AI can be a useful tool in knowledge construction if it encourages questioning, comparison, finding inconsistencies, and inquiry.

In an epistemological perspective, Uwakwe, A.C. pointed out that postmodern approach to knowledge is characterised by deep skepticism about the basic assumptions of Enlightenment rationality and modernist philosophy concerning the possibility of objective and universal knowledge. Postmodern knowledge has developed as a reaction to modernist epistemology. It was against its assumptions such as reason, scientific objectivity, and stable truths (Uwakwe,2025). This shows that, Epistemology or Theory of Knowledge can be described as the study of nature, sources, validity and limitation of knowledge, as well as distinguishing between justified belief and opinion. In the current study, knowledge is viewed not only as information that a learner possesses but also as critically analysed and justified knowledge that allows the learner to interpret, analyse and use the information obtained. This definition places human judgement and critical reflection at the centre of knowledge acquisition.

The Concept of knowledge acquisition

Knowledge acquisition is the process through which an individual acquires, interprets, understands, evaluates, and integrates knowledge. In conventional settings of education, there are various interrelated processes through which knowledge acquisition takes place and include teaching, reading, observing, experimenting, discussions, reflecting, practice, and interaction. According to Jayashri and Kalaiselvi (2019), Knowledge acquisition is the process of acquiring knowledge from a human master or from a group of specialists for enhancing knowledge-based systems. It involves the following processes which are intellectually complex: recognition, learning, communication, association, and reasoning. The philosophical roots of knowledge acquisition are related to competing schools of thought on the source of knowledge. These include Rationalism, which emphasises reason and intellectual reflection, and Empiricism, which places more emphasis on sense experiences and observations. Constructivist theories which are based on Jean Piaget and Lev Vygotsky are among these competing schools of thought. These perspectives contradict the notion of learners as empty vessels of knowledge. Criticism of the concept of education as a bank by Paulo Freire is especially valid here. According to Freire, education is not about filling empty heads with ready knowledge from a knowledgeable teacher; it is about dialogue in learning, formation of critical consciousness, and participation in the understanding of reality (Freire, 2000).

The notion of Ai-mediated knowledge acquisition is important for this research. It involves the process through which learners acquire information and understand it with the help and mediation of AI systems. The process involves intelligent tutoring systems, adaptive learning systems, automated feedback systems, AI-enabled search engines, virtual laboratories, conversational AI, and generative AI applications. Traditional knowledge acquisition can be represented as a four-element relationship between the **learner**, **teacher**, and **knowledge**. In this case, the introduction of AI results in the following relationship: Learner -- Teacher --Knowledge.. become increasingly: Learner --AI -- Teacher -- Knowledge, or in some cases: Learner -- AI -- Knowledge. The second relationship is even more questionable from the point of view of epistemology, as the learner can completely avoid the intermediary. It does not necessarily mean that AI replaces teachers, but it does mean that the teacher's role as the primary mediator of knowledge is changing.

The emergence of AI adds another dimension to this debate. Now the learner has a technology that can answer questions posed immediately, generate explanations, synthesise information, and help solve problems. This development would make the acquisition of knowledge quicker and easier. But it could also lead to the outsourcing of thinking, where learners rely on AI systems for crucial mental processes. Knowledge acquisition is therefore viewed as an active, reflective, and critical process through which the learner engages with information, determines its credibility, connects it with previous knowledge, and forms justified knowledge.

The Concept of Science Education

Science Education can be defined as the process of developing knowledge and understanding of the natural and physical world and the development of skills, attitudes and dispositions required for scientific investigation. It includes the study of the disciplines of biology, chemistry, physics, earth science, environmental science, and other relevant subjects. Science education differs fundamentally from memorisation of scientific information. It aims at developing scientific literacy, which includes understanding scientific ideas, reasoning scientifically, evaluating evidence and arguments, engaging in scientific inquiry, and making judgments on scientific matters.

Science education depends on a set of highly complex cultural values. They are ‘values that arise from practice and become sactified with time. The further they retreat into the background, the more taken-for-granted they become’ (Willard, 1985, as cited in Osborne, 2000). The most important of these is the duality between training (and the use of this word is very deliberate indeed) the future scientist and educating the future scientist.

The epistemology of science education is thus very crucial. Science concerns itself with questions of the reliability of knowledge about the natural world. Scientific knowledge is arrived at through careful observation, experiments, hypothesis generation, evidence collection, evaluation and peer review. The introduction of AI into science education therefore raises important questions about the nature of scientific learning. If AI provides students with immediate explanations and solutions, will learners still engage in the investigative processes through which scientific understanding develops? Alternatively, can AI facilitate deeper scientific inquiry by allowing learners to explore more possibilities, simulate experiments, analyse complex data, and receive immediate feedback?. One particular study that is worth considering in relation to the research is the recent systematic review carried out by Cheung et al. This review highlights the increasing role played by AI in K–12 science education in terms of personalised inquiry and generative AI. However, what Cheung et al. Emphasise was the need to gain an understanding of the epistemological nature of interactions between AI and science when students employ AI in producing, revising, and evaluating scientific knowledge (Cheung et al., 2025). It is thus evident that science education becomes an excellent case for examining AI epistemologically. Scientific learning requires learners to distinguish evidence from assertion, reliable claims from unreliable claims, and explanation from speculation. These same abilities are essential when interacting with AI systems.

The Concept of Epistemology

Etymologically, the concept of Epistemology came from the Greek words epistēmē ("**knowledge**") and logos ("**reason**"), and thus the discipline is also called the theory of knowledge. Epistemology is the discipline of philosophy that deals with the issue of knowledge. It is the study of basic questions relating to knowledge in terms of nature, origin, scope, justification, and validity. Some of the basic questions that lie at the heart of the discipline include: What is knowledge?, How is knowledge obtained?, What makes a belief justified?, How do we differentiate knowledge from opinions?, What are the limits of human cognition?. The discipline of Epistemology has a very long history in Western Philosophy and traces back its roots to ancient Greeks until today. Together with Metaphysics, Logic, and Ethics, it is one of the four traditional branches of philosophy and all great philosophers have had their contributions to it. The relevance of Epistemology to the study of Artificial Intelligence and Science Education cannot be ignored, since AI is now being used in activities traditionally related to knowledge.

The epistemological essence of AI is that it changes the conditions of people's encounters with information. In the past, a student might have consulted a textbook, teacher, library, or scientific journal. Today, a student can pose a question to an AI system and receive an immediate response. The ease of access may improve learning, but it also changes the relationship between the learner and the source of knowledge. This transformation raises several epistemological questions: Who is the source of knowledge when an AI system generates an answer?, How should learners determine whether AI-generated information is true?, Can an AI system be regarded as an epistemic authority?, What happens to human judgement when learners increasingly rely on machine-generated explanations?, Does access to an answer constitute knowledge?, How should students verify information produced by AI?. These questions demonstrate why AI in science education cannot be treated exclusively as a technical or pedagogical issue. It is also a philosophical issue concerning the conditions of knowing.

The UNESCO 2024 AI Competency Framework for Students is especially applicable in addressing the above epistemological challenge. The framework has identified four broad categories including human-centered approach, AI ethics, AI techniques and applications, and AI system design as well as three stages of development including understand, apply and create (UNESCO,2024). The framework underscores the importance of cultivating critical judgment of AI systems as opposed to just becoming their users.

The Epistemic Agency and the learner in the Age of Ai

The Concept of epistemic agency generally understood as a capability of an individual to engage actively and responsibly in processes of knowledge creation, evaluation, and justification. An epistemically agentic learner does not accept information from a seemingly authoritative source. Instead, an epistemically agentic learner poses questions, evaluates evidence, considers alternatives, and takes responsibility for beliefs. The concept of epistemic agency is particularly relevant in the AI context due to the fact that AI can look authoritative. A learner who receives a fluent answer from an AI system is likely to accept this answer as it is without checking its reliability. This situation may lead to a transfer of epistemic agency from the learner and teacher to the technology. Hence, the epistemologically responsible learner within an AI-supported learning environment should have at least the following five competences:

- **Questioning** : the competence of posing relevant and scientifically valid questions.
- **Verification** : the competence of verifying whether AI-based claims are true according to reliable sources.
- **Evaluation** : the competence of evaluating the quality, relevance, reliability, and extent of the information.
- **Interpretation:** the competence of understanding the information in contextually relevant scientific and social ways.
- **Responsibility:** the readiness to take personal intellectual responsibility for claims about knowledge rather than off-loading this responsibility onto AI (UNESCO,2024). Thus, this implies that AI literacy cannot be interpreted simply as the competence of using AI technologies. It should be epistemological AI literacy as well.

If the student employs AI in understanding a tricky topic, the technology is likely to enhance learning. However, if the student uses AI in completing all assignments, solving all problems, and making arguments, epistemic agency of the learner may deteriorate.

It raises questions against the established assumptions about epistemic authority. In the traditional academic environment, students are asked to refer to reliable sources, investigate the data, and analyse the authority of the published material. However, in the case of AI, the technology creates an apparently authoritative solution without laying a proper epistemic base. Rather than rejecting the use of AI, one must create the culture of verification.

Thus, the epistemic chain is: **Output of AI -- source identification -- independent verification -- comparison with credible literature -- evaluation -- either accepting or rejecting of the statement**...In science education, this process is especially relevant due to the nature of scientific knowledge that is provisional and empirical.

Meaning and Nature of Artificial intelligence (Ai)

Concept of AI did not come into existence all of a sudden in the context of the digital era; it has evolved slowly from philosophical notions related to human thought processes to current computerised applications. In order to understand the concept of AI in the context of scientific acquisition of knowledge, it is important to consider its meaning and history. Before venturing into the deep discussions, it is important to understand what AI is all about.

What is AI?

We have made claims about how interesting AI is, but we have not defined what it is. Years ago, there were several ways people attempted to define AI. While some viewed intelligence in relation to their ability to match human performance, others liked to think of an abstract notion of intelligence known as rationality, or loosely defined as doing the "**right thing**." Intelligence itself can be considered from another perspective, that is, either from the perspective of thought and reasoning or behavior. With these two aspects of AI—being human or rational, and thought or behavior—the possible combinations are four, all of which have existed and will exist. Let us look at the four approaches in more detail.

Acting humanly: The Turing test approach.

Turing's test was created by British mathematician Alan Turing in an attempt to avoid philosophical problems in trying to determine whether machines can think. In this test, a computer is considered to pass the test if the human being asking the questions cannot distinguish between answers provided by a computer and those offered by a person. The computer should be able to perform the following functions:

• **Natural Language Processing:** Ability to communicate effectively using human language,

• **Knowledge Representation:** Capacity to represent and store knowledge in memory,

• **Automated Reasoning:** Capability to reason and infer based on information obtained,

• **Machine Learning:** Ability to learn from experience and detect patterns.

Turing considered the physical imitation of a person as unnecessary in proving intelligence. Nevertheless, other researchers have suggested a total Turing test, which entails interaction without the use of objects and human beings in the physical world. For a robot to qualify in a total Turing test, it will be necessary to possess:

•**Computer vision and speech recognition to recognise the physical world;**

•R**obotics to interact with objects and navigate the physical environment.**

These six fields constitute the bulk of AI. Despite this, AI researchers have put in very little work on succeeding in the Turing test, believing that it is much more important to study the nature of intelligence. The attempt at achieving "**artificial flight**" was made possible when inventors ceased copying birds and focused on understanding wind tunnels and aerodynamics. Books on aeronautical engineering do not aim at creating machines that fly "so exactly like pigeons that they can fool even other pigeons."(Turing, 1950).

Thinking humanly: The cognitive modeling approach

For any program to posses human-like thinking, it is essential to understand how a human being thinks. There are three methods for understanding human thinking:

• **Introspection**—Catching one's own thoughts in passing;

• **Psychological Experimentation**—Observing what a person does; and

• **Brain Scanning**—Watching what a brain does.

After developing a sufficient theory of the mind, it is then possible to convert the theory into a computer program. When the input/output activity of such a program is consistent with similar behavior in humans, it indicates that some of the processes in the program might also exist in humans. The interdisciplinary study of cognitive science merges computer models from artificial intelligence and psychological experiments to formulate accurate and testable theories about human cognition (Wilson and Keil, 1999). At the beginning of AI, there was a common misconception of differentiating these two aspects. One could claim that some algorithm works well for a particular task and thus can be considered a model of human performance, or vice versa. Today, authors clearly distinguish one aspect from another. This has helped both disciplines progress faster. They help each other out; for instance, computer vision takes into account neurophysiological information.

Thinking rationally: The "laws of thought" approach

One of the earliest philosophers in Greece, Aristotle, was among those who sought to define "**correct thinking,**" or methods of reasoning that cannot be refuted. The arguments made using Aristotle's syllogisms led to a conclusion that was guaranteed to be true whenever the starting premises were true. An example of one such law of reason is "if Socrates is a man and all men are mortal then Socrates must be mortal". These laws of reason were meant to guide our thinking, and their study gave birth to the discipline called logic. In its traditional form, logic holds that there is knowledge of the subject matter that is certain—a situation which, unfortunately, rarely happens. Our knowledge of things like politics or warfare is not akin to our certain knowledge of the rules of chess or mathematics. The theory of probability fills this gap, allowing rigorous reasoning with uncertain information.

Acting rationally: The rational agent approach

Agent is just something that acts (the term agent comes from the Latin word ***agere*** which means **to act**). It is obvious that Computer program does some action, however, a computer agent is expected to perform certain additional actions – work autonomously, sense its environment, persist through time, adapt to changes, and formulate and follow goals. Rational agents are defined as those agents which try to perform such actions as will help them to reach the optimal result or at least to expect the optimal result in case of uncertain conditions. That is why the idea of developing rational agents in AI has been prevalent throughout the history of this field. First, logical methods have been used to build the rational agents with definite plans to reach certain goals; later, probabilistic approaches and machine learning have made it possible to construct rational agents able to choose the best option in uncertain situations. In brief, AI has always been concentrated on the research and development of proper agents.

Thus, in general, Artificial Intelligence can be considered as efforts towards creating machines that will be able to perform activities that traditionally needed human intelligence – such as the processes of making reasoning, learning, solving problems, etc. AI can also be considered in accordance with the classical approach from the computer science tradition. In other words, it can be regarded as the capacity of a computer or machine to carry out intelligent beings' activities (Copeland, 2026) .In this case, intelligence is defined as imitation of the activity of the brain – understanding, thinking, inferring, adapting (etc.).From an epistemological perspective, AI can be said to go against common beliefs about the concept of knowing – suggesting that knowledge is not unique to humans,but can be modeled algorithmically.

Historical Development of Artificial intelligence (AI) and Its Application to Education

The history of AI is closely tied to humans' long-standing search to comprehend intelligence and create technological means to imitate elements of intelligent behavior. While the current AI is usually associated with generative programs like ChatGPT, Gemini, Claude, and other large language models, the conceptual and technological roots of AI are much older. The history of AI can be viewed as a history of evolving theories of intelligence, knowledge, learning, thinking, and the possibility of inventing machines that could perform tasks traditionally associated with human beings. Understanding the history of AI is relevant to the present investigation since the revolution in knowledge acquisition processes in science education has not occurred suddenly with generative AI. Rather merely a new phase in the long history of technological evolution in education technology from mere information provision toward more advanced and intelligent technologies. This approach to the scientific discipline of AI will help to better understand why it is so hard to define the term.

The historical development of AI as a science has shown a great deal of diversity. On one hand, there are various strands interested in different capabilities of human cognition, like perception, representation, or reasoning. On the other hand, there is also a plurality of the approaches used for creating AI, or even **"an anarchy of methods."** Although new approaches are invented, there is a clear continuity in the historical development of the field of AI, where modern methods are based on those of decades ago and partly revive the dreams of the creators of the field (DiMatteo et al., 2022). Epistemologically speaking, the historical development of AI is important due to the fact that at each stage of development AI presents a new approach to defining concepts of "**knowledge**," "**learning**," "**reasoning**," and "**problem solving**." The symbolic approach was based on trying to emulate human reasoning through using rules and formal logic. Machine-learning approach changed the focus from logic to learning from data. Deep learning enables the machines to learn more complex skills like perception, natural language processing, and forecasting. Generative AI has developed systems that can create original content.

The Philosophical and Intellectual foundations of Artificial Intelligence

The intellectual roots of artificial intelligence can be traced to ancient philosophical thinking about human intelligence, reason, and thought. Philosophers wondered about these questions long before the advent of computers: Are there formal rules for drawing conclusions?; How is the mind created by a physical brain?; From where do we get our knowledge?; How is knowledge translated into action? And can reason be formalised?. Aristotle (384-322 BCE) was the first philosopher to define an exact set of rules for the rational mind. He created an informal system of syllogisms for proper reasoning that in essence meant mechanical derivation of conclusion from some basic assumptions. Ramon Llull (c. 1232-1315) came up with a reasoning system called "Ars Magna" or "The Great Art"(1305). Llull attempted to mechanise his system using an actual mechanical device: a set of paper wheels that could be rotated into different permutations.

Around 1500, Leonardo da Vinci (1452-1519) drew up plans for a mechanical calculator; recent experiments have shown that the plan is a workable one. The earliest calculating machine was made in about 1623 by the German scientist Wilhelm Schickard (1592-1635). The Pascaline was invented by Blaise Pascal (1623-1662) in 1642, and he said it “produces effects which appear nearer to thought than all the actions of animals.” Gottfried Wil-helm Leibniz (1646-1716) built a mechanical device intended to perform operations on ideas rather than numbers, but its range was quite small. In his 1651 book Leviathan, Thomas Hobbes (1588-1679) put forward the notion of a machine that thinks, “an artificial animal,” as he called it, saying “For what is the heart but a spring; and the nerves, but so many strings; and the joints, but so many wheels.” He also suggested that reason is just a kind of calculation: “For ‘reason'.. is nothing but ‘reckoning,’ that is adding and subtracting. ”It’s one thing to say that the mind works, at least in part, through logical or numerical calculation, and then to construct physical systems that simulate these rules. It’s another to say that the mind itself is such a physical system. Ren'e Descartes (1596–1650) gave the first clear discussion of the distinction between mind and matter. That a purely physical explanation of the mind apparently does not allow any free will at all. If mind is subject to only physical laws, it is deprived of free will just as much as a stone is free to choose whether it will fall down or not. Descartes was a dualist. It means according to his theory, human beings have the mind (soul or spirit) that goes beyond nature and its physical laws. As for animals, they do not have such dual qualities and thus can be seen as machines. The terms physicalism and naturalism are sometimes used to refer to the view that opposes the idea of the supernatural. Now, if we have a physical mind that works with knowledge, the question arises about the origin of the knowledge itself. Empiricism is characterised by the following dictum of John Locke (1632-1704) "Nothing is in the understanding, which was not first in the senses." David Hume's (1711-1776) book A *Treatise of Human Nature*, offered the following principle of induction: "general rules are obtained by the repetition of particular instances" (Stuart & Peter, 2020).

Based on the theories proposed by the Austrian philosopher Ludwig Wittgenstein (1889–1951) and the British mathematician Bertrand Russell (1872– 1970), the famous Vienna Circle – a group of philosophers and mathematicians who discussed problems in Vienna in the 1920s and 1930s, came up with the doctrine of logical positivism. Logical positivism maintains that all knowledge can be defined in terms of logical theories linked to observation sentences related to sensory inputs; therefore, logical positivism incorporates rationalism and empiricism. The confirmation theory by the philosophers Rudolf Carnap (1891–1970) and Carl Hempel (1905–1997) tried to explore how knowledge is obtained from experience by measuring the degree of certainty assigned to logical sentences in accordance with their association with observations that prove or refute them. The book by Rudolf Carnap entitled *The Logical Structure of the World (1928)* was probably the first theory about computation of the mind (Sigmund, 2017). The last element of the philosophical view of the mind is the relationship between knowledge and action. This problem is important to AI because intelligence involves both thinking and acting. In addition, in order to create an intelligent agent, we need to know how actions are justified. The philosophical significance of this development for AI lies in the assumption that at least some aspects of human reasoning can be represented in a structured and systematic manner. This assumption would later become central to symbolic AI, where intelligence was approached through the manipulation of symbols according to formal rules.

The Logical and Mathematical foundations of Artificial Intelligence

Modern AI has also been shaped by mathematics, logic, and computing. It raises the following questions: What are the rules for drawing proper conclusions?, What is computable?, How should we reason about uncertain facts?. Philosophers laid the groundworks for some basic concepts of AI, but the formalisation of this discipline was only possible when logic and probability were mathematised, and a completely new field of mathematics – computation – came into play. From the nineteenth and twentieth centuries onwards, it became more common to ponder whether there were any possibilities to mechanise mathematical calculations and logical operations. Formal logic originated from the works of philosophers from ancient Greece, India, and china, but the mathematical foundations of formal logic were laid down by George Boole (1815–1864), who developed the principles of propositional or Boolean logic (Boole, 1847). Gottlob Frege (1848–1925) built upon Boole's logic in 1879, expanding it to include objects and relations and thus establishing the basis of first-order logic used up to now. First-order logic was one of the key factors that prompted the work of Gödel and Turing and the emergence of computation itself (Stuart & Peter, 2020).

The Probability theory may be viewed as a generalisation of logic that takes account of uncertain probability information—a factor of utmost importance to AI. Gerolamo Cardano (1501 – 1576) was the first to formulate the concept of probability, viewing it as the potential results of gambling. Blaise Pascal (1623–1662) in his letter to Pierre de Fermat (1601–1665) in 1654 illustrated how the future of an unfinished gambling game could be predicted and how average payoffs could be assigned to the gamblers. Probability became an essential component of quantitative sciences, since it helped to handle uncertainty of measurements and theories. Thomas Bayes (1702–1761) formulated a method to update probabilities on the basis of new evidence; Bayes' rule is of vital importance to AI. Formalisation of probability, together with the collection of data, resulted in the birth of the science of statistics.

Gödel proved that there was an effective procedure that could establish the truth of any assertion made in the first-order logic of Frege and Russell, but that first-order logic was insufficient for capturing the principle of mathematical induction, essential to characterising the natural numbers. Gödel proved in 1931 that limits do exist to deduction. Gödel's famous incompleteness theorem demonstrated that in any formal theory as powerful as that of Peano arithmetic, the elementary theory of the natural numbers, there must be true assertions which have no proof in the theory. This important discovery can be interpreted to show that certain functions on the integers cannot be represented by an algorithm and therefore not computed. This prompted the British mathematician Alan Turing (1912–1954) to attempt to precisely define which functions were computable. In the paper **"Computing Machinery and Intelligence,"** published in 1950, Turing posed the problem of whether machines could think and introduced the imitation game for considering the intelligence of a machine. According to the Church-Turing thesis, the general concept of computability is identified with those computed by a Turing machine (Turing,1936). Turing was also able to prove that there were certain computations that cannot be performed by any Turing machine. For instance, no machine is able to determine whether the program will provide an output for the particular input or will keep on running infinitely. The idea of tractability has been even more influential to AI (Stuart & peter, 2020). In brief, tractability refers to those problems for which time necessary to solve increases exponentially as a function of the size of the problem. The theory of NP-completeness that is based on the works of Cook (1971) and Karp (1972) serves as a foundation for studying the tractability of different problems: all classes of problems that are reducible to NP-completeness problems can be considered intractable (although it has not been proven yet).

The Birth of Modern Artificial Intelligence :The DartMouth period

Are machines going to become smarter than humans in the future? No, says Jean-Gabriel Ganascia: in his work titled This is a myth inspired by science fiction. The computer scientist takes us through the history of the milestones in the field of artificial intelligence, explains some of the latest breakthroughs in technology, and raises ethical concerns that need answers. The scientific discipline of artificial intelligence started in 1956, in the course of a summer workshop convened by four American scientists – John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon – in the city of Hanover, in New Hampshire, USA. Ever since then, the phrase "artificial intelligence", which must have been invented to shock people, became so famous that everybody knows about it. This application of computer science has kept developing over the decades, and the technologies invented in the field have significantly impacted our world in the last sixty years (Ganascia,2018).

The founders of the scientific discipline of artificial intelligence believed that intelligence could be described and modelled in order to simulate it in computers. It was an era of great optimism. The researchers felt that computers had the potential to do tasks which involved reasoning, problem solving, linguistic capabilities and even learning. The significance of the Dartmouth era in relation to the current paper is the epistemological assumption that underlies it, that the human intelligence can be represented computationally. If reason could be made formal, it could be transferred into the machine. The use of computers in education is not new. It dates back well before the advent of the concept of artificial intelligence. During the eras of the 1960s and 1970s, Computer-Aided Instruction (CAI) systems were built, which could deliver programmed instruction to the students. The basic function of these systems included displaying of instructional content, questions and exercises, followed by feedback based upon the students' response. The ITS (Intelligent Tutoring Systems) are a definite advance over CAI systems.

Early work in intelligent tutoring can be traced to the 1970s, including Jaime Carbonell's SCHOLAR system, which was supposed to teach students through dialogue on geography issues. Later, in such systems as GUIDON, experts' knowledge was introduced into the educational process. According to historical literature, the 1970s is when AI started it's in use in education and intelligent tutoring systems (Carbonell, 1970 and Clancey, 1979). The usage of such a system has marked an epistemological change in the approach to knowledge acquisition. At first, the computer was seen as a simple tool of delivering knowledge, but later as a tool that understands something about the learner and changes the educational process accordingly. The development of an intelligent tutoring system is especially promising for science education because of the existence of complex conceptual structures and various misunderstandings that arise. An intelligent tutoring system could potentially identify these difficulties and provide targeted explanations or exercises.

The Development of AI in Education in the Twenty-First Century

There was a great expansion in the use of AI in educational settings during the twenty-first century. AI started shifting from research purposes into practical educational technologies such as adaptive learning systems, automated assessment, learning analytics, intelligent tutoring systems, recommendation systems, chatbots and educational robotics. A 2024 systematic review of AI in K–12 education identified applications including ,intelligent tutors, chatbots, educational games, AI robots and model building tools, educational games, AI robots, and model-building tools, demonstrating the increasing diversity of AI technologies used in educational environments (Martin et al., 2024).. Thus, the field of AI in education has undergone great development, and current research focuses on applications of AI in education, models of learning, assessment, learning analytics, personalised learning and ethical issues. This time period is significant because AI started becoming an inseparable part of the process of learning. The learner was now able to communicate with educational technologies that were able to adapt to the needs of the student, predict their performance, identify weaknesses and provide feedback. In science education, this time period led to the creation of personalised learning and inquiry. AI could help learners explore scientific phenomena, analyse data, find patterns and get explanations based on their needs. The historical transition can therefore be summarised as follows:

Computer-Assisted Instruction -- Intelligent Tutoring Systems -- Adaptive Learning -- Machine Learning -- Deep Learning --Generative AI. Each stage represents a movement towards increasingly complex forms of technological participation in the learning process.

The Emergence of Generative Artificial Intelligence

The emergence of generative AI represents a major turning point in the development of AI and learning. Where older AI for education had a function, whether it be evaluating responses, recommending material, or providing adaptive education, generative AI can create new texts, images, coding, and other types of content based on user prompts. The release of ChatGPT in November 2022 boosted the public knowledge about generative AI applications in education dramatically. Since then, more and more people started experimenting with large language models for research, writing, explanations, tutoring, translations, brainstorming, and problem solving. For example, a biology student may ask an AI to explain cellular respiration at various degrees of complexity. Similarly, a chemistry student may ask for an explanation of a chemical reaction, while a physics student–for an explanation of a problem. A teacher can use AI to generate instructional materials or alternative explanations.

But there are also important epistemological considerations. With the advent of generative AI, the way a learner engages with knowledge has changed since a learner now interacts with a machine that responds rather than providing access to information. UNESCO has highlighted that the development of generative AI is part of the bigger picture of technological revolution that has brought the process of learning through various digital revolutions starting with personal computers, then the internet, followed by mobile technologies, and finally generative AI. UNESCO has pointed out the main epistemological challenge which is that the generative AI produces content that may look authoritative even if it is wrong (UNESCO,2023).

AI in Science Education in the African and Nigerian Context

The historical process of AI in education needs to be understood in relation to Africa as well. As noted above, the adoption of AI in education in Africa is taking place under conditions of an imbalanced technological infrastructure, digital divides, lack of access to quality education materials, shortage of teachers, and different levels of institutional capacities. The history of AI in African education thus cannot be understood only through its process of technology adoption, but also in terms of technological justice and epistemic inclusion. In case where AI technologies have been built using data and knowledge systems generated mainly from outside African contexts, it would mean that African students would end up facing AI systems which will not properly reflect local realities, languages, cultures, and educational demands. This problem is particularly important for science education. Science is indeed universal to many extents, but the education and application of science takes place in specific social and cultural settings.AI-supported science education in Nigeria and Africa should therefore combine global scientific knowledge with sensitivity to local realities.

AI is increasingly becoming popular among science education research carried out in Nigerian Institutions because there is a need to explore innovative ways to improve the quality of teaching, engagement of the learners, and research outputs. One major applications involves the use of learning analytics that are driven by AI in analysing the performance of learners, recognising the gaps in learning, and evaluating the efficiency of the teaching process. The learning analytics allow researchers to analyse the patterns of learning scientific concepts by the learners, measure the progress made, and predict the difficulties that the learners might face (Adebayo & Abdulrahman, 2023).

The recently recognised importance of competency frameworks for AI becomes relevant in this context. According to UNESCO's 2024 framework for students, the education system is supposed to develop learners as the responsible and creative users and co-creators of AI, and the teacher framework is focused on the competencies needed to leverage the opportunities of AI while managing associated risks (UNESCO, 2024). However, the application of such frameworks should consider the local situation in Africa.

The Epistemological Transformation of Knowledge Acquisition through Artificial Intelligence in Science Education.

The integration of AI in science education represent more than just the introduction of new instructional technology. Instead, it involves a radical change in the way learners experience, interpret, evaluate, and produce knowledge. Generally speaking, science education is structured based on an epistemic relationship between the teacher, learner, scientific data, textbooks, laboratory and other sources of knowledge. AI adds new agent to this epistemic relationship, as students can now communicate with AI systems that explain scientific notions, generate hypotheses, analyse data, give feedback, simulate conversation, and answer difficult questions. As a result, the learning process is increasingly becoming a computer-mediated process. Particularly, the advent of generative AI means even more in this respect. The difference from the previous educational technologies that serves as storage or delivery tools of some information is that generative AI allows communicating with learners in an apparently interactive manner and gives new answers to questions. That is why the recent research on science education has paid attention to AI as a source and mediator of epistemic authority. The emergence of generative AI challenges the traditional dominance of human experts and established knowledge sources while raising questions about human epistemic agency and the responsibility to evaluate knowledge claims (Lee et al., 2026).

Science education has often been based on the transmission of existing scientific knowledge from teacher to learner. In science classes, teachers explain scientific knowledge, books contain existing knowledge, and learners receive this knowledge. However, AI offers a new approach to knowledge learning. If a student studies genetics, he or she may ask an AI system to give an explanation of DNA replication, compare different explanations, generate questions about this issue, and offer feedback regarding an explanation of genetic inheritance. Learners do not just receive knowledge from a teacher or textbook; they interact with the system participating in the formation and organisation of knowledge. Knowledge co-construction is particularly applicable to this case. AI is not just a tool of delivering existing knowledge. It may generate alternative explanations, pose questions, make hypotheses and give feedback by interacting with learners. Recent research on the use of customised generative AI chatbots in science education shows that such artificial intelligence can serve as a dialogical partner with multiple perspectives, reasoning, and argumentation that are closely related to the epistemic practices of science (Tang & Putra, 2026). However, it should not be assumed that coconstruction entails automatic acceptance of AI knowledge. The role of the learners in evaluating the generated knowledge remains intact. In scientific learning, knowledge co-construction should include the following steps:

Questioning -- AI interaction -- Data collection -- Critical analysis -- Scientific thinking -- Knowledge construction.

Thus, artificial intelligence might be a helpful agent in scientific research, yet the learner has to take an active part in checking whether the knowledge claim is reliable. In all, artificial intelligence is transforming knowledge acquisition in science education through the introduction of a new technological agent in the educational process between learners, instructors, scientific data and knowledge.

Artificial Intelligence and the Transformation of Knowledge Acquisition in Science Education: The African and Nigerian Context.

These epistemological transformations, however, do not occur identically in all places, as they intersect with infrastructure, policies, and historical circumstances in ways which are particularly true for Nigeria and other parts of Sub-Saharan Africa. Okoye & Ekechukwu (2022), for instance, claim that there is great potential for the transformation of Nigerian education through the use of AI, with its possibilities for personalised education and easing the overload from over-stressed teachers, but that it is limited by the lack of reliable electricity, broadband coverage, and relevant local content available in digital form. Udekamna & Nwafor (2022), likewise, argue that the use of AI-powered tools is just beginning in the sphere of Nigeria's formal education system, and that such a change requires careful change management, training for employees, and equal allocation of resources in order to prevent increasing inequalities between well-provided and poor-resource institutions. Adediran et al. (2024) make a similar point, but this time about the Nigerian economy as a whole, claiming that the main barriers to adoption of AI in Nigeria are unstable infrastructure, shortage of trained personnel and inadequate regulation.

Regarding the notion of epistemic authority and teacher-student relationship, in the traditional Nigerian science class, the teacher has not been merely source of information but the prime epistemic authority – someone whose opinion defines which explanations are true, which experiments are reliable, and which questions should be considered. In bringing AI instruments into the classroom, one does not make the teacher give up his/her position but creates the presence of another, nonhuman source of seemingly authoritative answers to questions posed by the students. The Literature on epistemic authority indicates the way to retain and strengthen the position of the teacher in the face of the new challenge. Since AI, as explained above, does not have the intentionality and the capacity to take responsibility for its answers (Husna,2025), the outputs still require the judgment of a human expert who will assess the reliability of results, integrate them into the system of knowledge, and show how certain explanations get verified and others get discredited. Jose et al. (2025) carefully stated that in the presence of AI devices, the role of the teacher as the mentor of critical and reflective thinking increases as students may start confusing fluency with comprehension. For Nigerian science education, where class sizes are often large and teacher-student ratios strained, this suggests that AI is best conceived not as a replacement for the teacher's epistemic authority but as an instrument that, properly supervised, can extend the teacher's reach while leaving the responsibility for judgement, verification, and mentorship firmly in human hands.\

Discussion and Conclusion

In this paper, it is argued throughout that artificial intelligence has changed the epistemic basis of science education by impacting how scientific knowledge is accessed, created, validated, communicated and used. Unlike earlier educational tools which serves the purposes of information storage and delivery, the generative AI tool takes part in the actual learning process by explaining concepts, answering questions, facilitating inquiry, and serving as an intermediary between learners and scientific knowledge. As such, the change introduced by AI is not only technological but also epistemic. The historical review showed that the evolution of AI has been from simple symbolic machines to advanced machine learning and generative AI models able to engage the learners into interactive dialogue about science. This process was accompanied by profound changes in science education shifting from the teacher-centred process of knowledge transmission to an inquiry-based learner-centred and technology-enhanced approach. From the point of view of epistemology, the research revealed that in science education the process of knowledge acquisition has changed from teacher-mediated to human-AI-mediated one. Historically, teachers, textbooks, laboratories and scientific communities used to be the primary holders of the scientific knowledge. Nowadays, AI plays the auxiliary but increasingly important role in the network of knowledge. Nevertheless, the research suggests that this is not the replacement of the teachers or devaluation of scientific inquiry. On the contrary, this requires the reassessment of the role of the teacher from being the carrier of the information to being the epistemic guide helping the learners assess, verify, interpret and contextualise the information generated by AI.

One of the key findings of the study is that AI not only offers more educational opportunities, but also presents new epistemological dangers. On one hand, AI has the potential to democratise access to scientific knowledge, to customise learning processes, to facilitate inquiry-based learning, to provide instant feedback, to allow for differentiated instruction, to engage learners in complex scientific knowledge. The study identified a number of epistemological dangers. For example, AI can deliver incorrect information, fabricate references, perpetuate algorithmic biases, or display uncertain knowledge as being definite. All these features make it challenging for learners, especially those who have little scientific knowledge, to differentiate between scientific knowledge and something that seems true but is not. Another key finding is related to the connection between AI and critical thinking. The study has shown that AI has dual capabilities.AI if used properly, it can encourage scientific reasoning through comparative explanations, hypothesis formulation, evidence analysis, and scientific discussion. The emergence of generative AI in particular, has transformed the existing dynamics between teachers, students, and scientific knowledge by developing computer systems that can interact and take part in educational dialogues, as well as assist in scientific inquiries.

Thus, the study has revealed that AI holds a great potential to enhance science education using personalised learning, increased access to scientific information, inquiry-based learning, adaptive feedback, and increased educational opportunities. In the case of Nigeria and other African nations, which are experiencing a lack of educational resources and skilled science teachers, these potentials provide many opportunities to improve the situation in terms of science education. The incorporation of AI technologies into educational process will require large investments into infrastructure, teacher training, equitable access to technologies, changes in curriculum, increasing AI literacy, and appropriate educational policies. Moreover, it is essential to design and implement AI in a way that will respect African languages, indigenous knowledge, local scientific priorities, and cultural diversity in order to avoid epistemic exclusion and technological dependency. The transformation of knowledge acquisition using AI technologies must not be considered as a change from human intelligence to AI technologies but as an establishment of a collaborative relationship.

References

Adebayo, O., & Abdulrahman, A. (2023). Learning analytics and the analysis of patterns in learning scientific concepts. *Journal of Educational Technology and Science*, 14(2), 115–128.

Adediran, E., Sakpere, W., & Ogunyinka, T. (2024). Artificial intelligence in Nigeria: Challenges and opportunities. *SSRN Electronic Journal*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5269530

Bhutani, G., & Wadhwani, R. (2018). The impact of Artificial Intelligence on higher education: A review. *Journal of Engineering Research and Applications*, 8(3), 20-24.

Boole, G. (1847). *The mathematical analysis of logic, being an essay towards a calculus of deductive reasoning*. MacMillan, Barclay, & Macmillan.

Carbonell, J. R. (1970). AI in CAI: An artificial-intelligence approach to computer-assisted instruction. *IEEE Transactions on Man-Machine Systems*, 11(4), 190–202.

Cheung, K. K. C., Long, Y., Liu, Q., & Chan, H. Y. (2025). Unpacking epistemic insights of artificial intelligence (AI) in science education: A systematic review. *Science & Education*, 34(2), 747–777.

Clancey, W. J. (1979). Tutoring rules for guiding a case method dialogue. *International Journal of Man-Machine Studies,* 11(1), 25–49. https://doi.org/10.1016/S0020-7373(79)80004-8

Copeland, B. J. (2026). *Artificial intelligence (AI)*. Encyclopedia Britannica. Retrieved from https://www.britannica.com/technology/artificial-intelligence

Dewey, J. (1938). *Logic: The theory of inquiry*. Henry Holt and Company.

DiMatteo, L. A., Poncibò, C., & Cannarsa, M. (Eds.). (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge University Press.

Freire, P. (2000). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). Continuum. (Original work published 1968).

Garofalo, J., & Farenga, S. (2025). Science Teacher Perceptions of the State of Knowledge and Education at the Advent of Generative Artificial Intelligence Popularity. *Science & Education,* 34, 893–912.

Ganascia, J.-G. (2018, June 25). *Artificial intelligence: Between myth and realit*y. The UNESCO.https:// Courier.unesco.org/en/articles/Artificial-intelligence-between- myth-and-reality.

Husna. (2025). Epistemic authority and legitimacy in the age of generative AI: A normative framework for evaluating AI as a knowledge-formatter in scientific inquiry. *International Journal of Progressive Sciences and Technologies* (IJPSAT).

Jayashri, N., & Kalaiselvi, K. (2019). Knowledge acquisition – Scholarly foundations with knowledge management. *International Journal of Advanced Studies of Scientific Research*, 3(12),334-339.

Jose, B., Cleetus, A., Joseph, B., Joseph, L., Jose, B., & John, A. K. (2025). Epistemic authority and generative AI in learning spaces: Rethinking knowledge in the digital age. *Frontiers in Education*, 10, Article 164768.

Lee, G., Yun, M., Zhai, X., & Crippen, K. (2025). Artificial intelligence in science education research: Current states and challenges. *Journal of Science Education and Technology*, 35(1), 1–18. Springer Nature.

Martin, F., Zhuang, M., & Schaefer, D. (2024). Systematic review of research on artificial intelligence in K-12 education (2017–2022). *Computers and Education: Artificial Intelligenc*e, 6, 100195. doi.org

Miao, F., & Holmes, W. (2021). *Artificial Intelligence and Education*. Guidance for Poli-cy-Makers. UNESCO.doi.org.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (1955). *A proposal for the Dartmouth summer research project on artificial intelligence.* Department of Mathematics, Dartmouth College.

Nurnaningsih, K., Sugiarti, S., & Jenuri, J. (2026). Epistemology of Education in the Era of Artificial Intelligence: A Philosophical Study of Science for Future Teachers. *Journal of Innovation and Research in Primary Education,* 5(2).

Okoye, A., & Ekechukwu, L. (2022). The role of artificial intelligence in transforming Nigerian education: Prospects and challenges. African *Journal of Educational Research,* 26(2), 45–58.

Osborne, J. (2007). Science education for the twenty first century. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(3), 173–184.(Original work cited by Osborne referring to Willard,(1985). *A theory of Agumentation*. University of Alabama Press.

Russell, S., & Norvig, P. (2020). *Artificial intelligence: A modern approach* (4th ed.). Pearson.

Sheikh, H., Prins, J., & Hoorn, E. (2023). Artificial intelligence: Definition and background. In H. Sheikh, C. Corrao, & R. van der Spoel (Eds.), *Mission AI: Ownership and control of artificial intelligence* 9–23. Springer. https://doi.org/10.1007/978-3-031-21448-6_2

Simbolon, L., Manugeren, M., & Barus, E. (2025). Does AI know things? An epistemological perspective on artificial intelligence. *Journal of English Language and Education*, 10(5), 1022–1028.

Sigmund, K. (2017). *Exact thinking in demented times: The Vienna Circle and the epic quest for the foundations of science*. Basic Books.

Shang, N., et al. (2025). *The Epistemology of Artificial Intelligence: Understanding Knowledge Creation and Validation in the Digital Age*. ResearchGate.

Tang, H., & Putra, P. D. (2026). Generative AI as a dialogic partner: Enhancing multiple perspectives, reasoning, and argumentation in science education with customised chatbots. *Journal of Science Education and Technology*,35(1),1-13.doi.org.

Turing, A. M. (1950). Computing machinery and intelligence. *Mind*, 59(236), 433–460.

Uwakwe, A. C. (2025). Epistemological issues in the postmodern era. *International Journal of Critical Inquiries (IJOCIN),* 1(1). ACJOL.

Udekamna, A., & Nwafor, A. O. (2022). Artificial intelligence in Nigerian education: Challenges and opportunities. *International Journal of Education, Social Studies and Management*, 2(1), 45–54.

UNESCO. (2024). *AI competency framework for students*. Paris: UNESCO Digital Library. https://unesdoc.unesco.org/ark:/48223/pf0000391105.

UNESCO. (2023). *Guidance for generative AI in education and research*. United Nations Educational, Scientific and Cultural Organisation. https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research

Wilson, R. A., & Keil, F. C. (Eds.). (1999). *The MIT encyclopedia of the cognitive sciences*. MIT Press.