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Deploying AI as Teachers in the Rural Areas of Ghana

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Abstract

AI is the science of making machines does things that require intelligence. It involves building computer programs that aim at performing tasks that require some intelligence. The objective of AI therefore is to make life easier by handling complex and repetitive daily tasks. AI is consequently changing society by reshaping the way things are done. The development of the rural areas of Ghana has been left behind in terms of education. This is attributed to lack of basic amenities, education and infrastructure. Consequently, teachers refuse posting to remote areas of Ghana. This paper proposes the use of AI as teachers in the rural areas of Ghana. In an experiment conducted it was concluded the use of AI and the provision of the needed infrastructure can promote the development of rural areas and ensure sustainable development. This paper therefore outlines the significance of AI and how it can be utilized in the rural areas of Ghana to help bridge the gap that exists between education in the rural and urban areas of Ghana for sustainable development.

Keywords: Artificial intelligence; Teaching or education; Rural areas; Development

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Introduction

Artificial Intelligence is the branch of computer science that describes the capability of machine to learn like humans and to respond to certain behaviors. In other words, AI is making computers behave like human beings [1-3]. This is done to enable computers to solve complex problems by the applications of processes that are analogous to the human reasoning processes. The academic roots of AI, and the concept of intelligent machines is found in Greek Mythology but after modern computers became available after World War-II, it became necessary to create programs that performed difficult academic tasks. The study of logic led directly to the discovery of the programmable digital electronic computer, based on the work of mathematician Alan Turing and others. Turing's theory of calculation suggested that a machine, by shuffling symbols as simple as "0" and "1", could replicate any conceivable act of mathematical assumption [4]. This, along with simultaneous discoveries in neurology, information theory and cybernetics, inspired a small group of researchers to begin to seriously think of the possibility of structuring an electronic brain.

Artificial Intelligence however was first proposed by John McCarthy in 1956 in academic conference and eventually the idea of machines operating like human beings arose to be the center of attraction and attention by scientist's mind and the possibility to make machines have the same ability to think and learn by itself was introduced by the mathematician Alan Turing. Alan Turing was able to put his hypotheses and questions into actions by testing whether "machines can think"? After series of testing it was realized that it is possible to enable machines to think and learn just like humans [5,6]. This however led to philosophical issues about the nature of the mind and the ethics behind building or constructing artificial beings, issues which have been addressed by myth, fiction and philosophy in times past. In recent time however, AI has become an essential part of the technology industry: assisting in the heavy lifting for many of the most difficult problems in computer science. The central challenges of AI research include reasoning, information, planning, learning, communication, perception and the ability to

move and manipulate objects. There are an enormous number of tools used in AI, including versions of search and mathematical optimization, logic, methods based on probability and economics, and many others. In this paper we give an overview of AI and then propose the use of AI as teachers in the rural areas of Ghana due to lack of teachers and infrastructure. Rural areas of Ghana have been left out in terms of development. This is due to the refusal of trained teachers to take up postings to these areas due to lack of infrastructure such as classrooms, roads, hospitals, and basic amenities such as water and electricity. This paper visited some of the rural areas of Ghana to study and observe the environment, the people and the influence of education on their daily lives. It was revealed that given the necessary infrastructure and equipment the lives of the rural inhabitants can be transformed in order to contribute to the sustainable development of the individual as well as the society enshrined in the UN sustainable development goals. The rest of this paper is organized as follows: section I is the introduction, section II and III look at on the components of AI and the types of AI respectively. Section IV discusses the framework for the implementation of AI in rural areas in Ghana and section V focuses on deploying AI as teachers in schools in the rural areas of Ghana. Also, section VI discusses the challenges to be addressed with respect to the implementation of AI as teachers in rural areas, while section VII is the conclusion. The reference is found in section VIII.

Components of AI

The main components of AI according to research are: learning, reasoning, problem solving, perception, and language understanding [7-9].

Learning: Learning is distinguished into a number of different forms. The simplest is learning by trial-and-error. For instance, a simple program for solving mate-in-one chess problems will try out moves at random until one is found that achieves mate. The program remembers the successful move and next time the computer is given the same problem it is able to produce the answer immediately. The second form of learning is rote learning. This form of learning is usually implemented in computers without any difficulties. Generalization is the third form of Learning. Generalization leaves the learner with the skills to perform better in situations not encountered before. For instance a program that learns past tenses of regular English verbs by rote learning, will not be able to produce the past tense of e.g. "jump" until presented at least once with "jumped", while a program that is able to generalize from examples is able to learn the "added" rule, and as a result can form past tense of "jump" without any previous encounter with the verb. Sophisticated modern techniques enable programs to generalize complex rules from data.

Reasoning: This is the second component of AI. It involves making inferences suitable to a situation at hand. Inferences are categorized into two as either deductive or inductive. An example of the deductive inference is "Fred is either in the museum or the cinema; he is not in the cinema; so, he is in the museum". An example of inductive inference is: "Previous accidents just like this one has been caused by instrument failure; so probably this one was caused by instrument failure". The distinction between the two is that, in the deductive reasoning, the truth of the premises guarantees the truth of the conclusion, while in inductive reasoning, the truth of the premises gives support to the conclusion that the accident was caused by instrument failure, however further investigation may disclose that, although premises is truth, the conclusion is false. A lot of success has been seen in programming computers to draw inferences, particularly with deductive inferences. Nonetheless, a program cannot be said to reason by virtue of being able to draw inferences. Thus, reasoning consists of drawing inferences that are relevant to the task or situation at hand. Consequently, a challenge confronting AI is the ability of computers to distinguish what is relevant and what is not relevant.

Problem-solving: In AI problems are generally of the form: given a set of data, find x. This helps to address a variety of problems. These include finding winning moves in board games, recognizing and identifying people from their photographs and planning series of movements that enable a robot to carry out a given task.

Problem-solving techniques in AI are divided into two as special-purpose and general-purpose. A special-purpose technique is tailor-made for a specific problem, and often exploits very specific features of the situation in which the problem is embedded. On the other hand, a general-purpose technique is applicable to a wide range of different problems. One general-purpose technique used in AI is means-end analysis, which involves the step-by-step reduction of the difference between the current state and the goal state. The program selects actions from a list of means which in the case of, a simple robot, may consist of the activities such as pickup, putdown, move forward, move back, move left, and move right until the current state is transformed into the goal state.

Perception: In perception the environment is scanned by means of various sense-organs, real or artificial, and processes internal to the perceiver analyze the scene into objects with their features and relationships. Analysis however, is made complex since one and the same object may present many different appearances on different occasions, depending on the angle from which it is viewed, whether or not parts of it are projecting shadows, etc. Nevertheless, artificial perception is well advanced and seen in a self-controlled car-like device to drive at moderate speeds on the open road, and a mobile robot to roam through a suite of busy offices searching for and clearing away empty soda cans. For instance, one of the earliest systems to integrate perception and action was FREDDY, a stationary robot with a moving TV 'eye' and a pincer 'hand' by Edinburgh University during the period 1966-1973 and under the direction of Donald Michie. FREDDY had the ability to distinguish a variety of objects and able to assemble simple artifacts, such as a toy car, from a random heap of components under instructions.

Language-understanding: A language is defined as a system of signs that by convention has meaning. For instance, traffic signs, forms a mini language, the same applies to the hazard-ahead sign which indicate hazard ahead. This meaning byconvention distinctive of language is very different from what is called natural

meaning, in statements like 'Those clouds mean rain' and 'The fall in pressure means the valve is malfunctioning'.

An important characteristic of full-fledged human languages, such as English, which distinguishes them from, for instance bird calls and systems of traffic signs, is productivity. Thus, a productive language is rich to enable an unlimited number of different sentences to be formulated within it. Nonetheless it is quite easy to write computer programs that are able, in severely restricted contexts, to respond in English, fluently, to questions and statements, for example the Parry and Shrdlu. However, neither Parry nor Shrdlu actually understands language. An appropriately programmed computer can use language without understanding it, in principle even to the point where the computer's linguistic behavior is indistinguishable from that of a native human speaker of the language. What, then, is involved in genuine understanding, if a computer that uses language indistinguishably from a native human speaker does not necessarily understand? There is no universally agreed answer to this difficult question. According to one theory, whether or not one understands depends not only upon one's behavior but also upon one's history. In order to be said to understand one must have learned the language and have been trained to take one's place in the linguistic community by means of interaction with other language users.

Types of AI

AI is classified into three main categories as: strong AI, applied AI, and cognitive simulation or CS. We give a brief description of each category in this section.

Strong AI

The objective of strong AI is to build machines whose overall intellectual ability is indistinguishable from that of a human being. According to Joseph Weizenbaum of the MIT AI Laboratory, the ultimate goal of strong AI is "nothing less than to build a machine on the model of man, thus a robot that is to have its childhood, to learn language as a child does, to gain its knowledge of the world by sensing the world through its own organs, and ultimately to contemplate the whole domain of human thought [10]. Strong AI as it is popularly known was introduced category in 1980 by the philosopher John Searle, of the University of California in Berkeley. According to a survey it is envisioned that strong AI will eventually lead to the creation of computers whose intellectual abilities greatly exceeds that of human beings. On the other hand, Edward Fredkin, also of MIT AI Lab, has advocated that these machines "might keep us as pets". Although strong AI has attracted the attention of the media, most AI researchers view strong AI as not worth pursuing due to extreme difficulties problems in the past. Furthermore, little progress in strong AI has been made till date [11].

Applied AI

Comparing strong AI to applied AI or advanced information processing, applied AI's aims to produce commercially viable "smart" systems; for instance, a security system that is able to recognize the faces of persons legitimate to enter a particular building. Applied AI has consequently enjoyed significant success.

In cognitive simulation, computers are used to test theories about how the human mind works: for instance, how to recognize faces and other objects, or about how to solve abstract problems (such as the "missionaries and cannibals" problem described later). Theories to be tested are expressed in the form of a computer program and the program's performance at the task e.g. face recognition is compared to that of a human being. Computer simulations of networks of neurons have contributed both to psychology and to neurophysiology (some of this work is described in the section Connectionism). For instance, the Parry program was written in order to test a particular theory concerning the nature of paranoia. Researchers in cognitive psychology typically view CS as a powerful tool.

Materials and Methods

Frame work

In Ghana, a settlement of at least 5,000 of the population is considered an urban area, while a community with a population of less than 5,000 is classified as a rural area [12]. Ghana, Education is largely provided by the government and most times administered by the Ministry of Education and Ghana Education Service. Although rural areas can provide family-oriented settings, lower crime rates, fresh air, and an enhanced quality of life, many teachers refuse rural postings due to concerns about the quality of housing, classroom facilities, healthcare, school resources, and opportunities for professional development and language barriers [13-16].

Ghana's efforts at raising the living standards of her people and ensuring economic growth have, however, left a legacy of extreme disparities in development in terms of the demographic and settlement patterns, distribution of social infrastructure and levels of economic activity. This has resulted in substantial differences between urban and rural settings with regard to the distribution and quality of educational facilities and manpower, just as levels of utilization of resources and access to tertiary education also differ slightly between urban and rural schools [17].

Increased rural–urban migration has also brought millions of people living in rural areas to the urban centers. Variations in teacher–student ratios, human resource capacity, provision of educational infrastructure, and other facilities have also led to rural, urban, and regional differences in educational opportunities in different parts of Ghana [18-21].

Rural schools in Ghana lack good infrastructure and facilities, they have low enrollment, less qualified teachers, and fewer textbooks, and other teaching and learning materials, whereas urban schools are generally overstaffed with qualified teachers, are overenrolled, better funded, and monitored, have better infrastructure and adequate resources to work with the achievement gap between urban and rural schools is a pressing

problem today because past approaches at closing this gap have been largely urban biased in character.

In it was stated that there were 40,000 teaching vacancies in Ghanaian basic schools out of which 24,000 were filled by untrained teachers. Juxtaposing this national figure to the rural context one wouldn't be wrong at all to conclude that a huge majority of these vacancies will be found in the rural areas [22].

Deploying and using AI as teachers in schools in rural areas of Ghana

Education is the key to development in any country. However, in Ghana, despite effort by the government to ensure the realizations of quality education, a lot of work still needs to be done as the Ghanaian educational sector is faced with several challenges, especially in rural areas.

Most rural areas in Ghana experience challenges with regards to the educational sector: lack of the basic facilities for children to access education, lack of school building and its facilities, lack of human resources to fill the minimum criteria of the school, long-distance between homes and school, lack of books/resources, library facilities, computer lab, etc. have turned out to be the hindrances for societies in the rural areas of Ghana. Coupled with these however are recruiting and retaining qualified teachers for schools in rural areas of Ghana.

According to a recent national study of teacher demand and supply reports, there was a shortage of 40,000 trained teachers in basic schools i.e. the first nine years of schooling for ages 6 to 15, comprising six years primary and three years junior secondary, with untrained teachers filling 24,000 of the vacancies. The study also indicated that 'schools in the urban areas in the main have their full complement of teachers' but 'it is in the rural areas, especially in the deprived rural areas that teacher shortages are most severe [23,24].

For many years the Ministry of Education (MOE) and its implementing body for pre tertiary education, the Ghana Education Service (GES), have resorted to recruiting people with no teaching qualification or average qualification for schools in rural areas of Ghana. Popularly known as 'Pupil Teachers'. In Ghana, these teachers are not professionals and most often consist of untrained teachers. These teachers have contributed and still contribute immensely to the nation by providing invaluable services to basic education in Ghana. Nonetheless if the nation is committed to achieving quality and equity of educational experience across the nation and for that matter all children, then there is the need to ensure that qualified teachers with the necessary and needed skills are posted to all schools in the rural areas of Ghana. However, since this is not possible as qualified teachers often refuse postings to these areas due to lack of basic amenities and infrastructure, we propose the deployment of AI as teachers to help address the challenge. The academic world has become so expedient and personalized due to various applications of AI for education. This indeed is changing the way people learn: educational materials and resources are accessible to all through smart devices and computers. In the era of the Covid-19 pandemic, students do not need to physically be present in the classroom if the necessary infrastructure such computers and internet connection are made available and readily accessible all over the nation. Thus, quality education can be achieved for all if Ghana's commitment to the objectives of Education for All (EFA) and the Millennium Development Goals (MDG), and its constitutional mandate to provide free basic education to its citizens is channeled through AI. For instance, strong AI, applied AI and cognitive AI can be deployed in most rural areas to enhance and promote quality education. According to a study published by eSchool News, by the year 2021, the application of AI in education and learning will be increased by 47.5%. The impact of this technology will be felt from the lowest education levels through higher learning institutions. This will create adaptive learning techniques with tailored or specific tools for improving the learning experiences. Artificial Intelligence might inform the students how their career paths look like depending on their goals thus assisting them beyond academics [25].

Currently applied and cognitive AI is being used all around. For instance, in administrative tasks, by allowing institutions to minimize the time required to complete difficult tasks and ensuring that lecturers or teachers can spend more time with students. Thus, AI can be used to automate administrative obligations for teachers in academic institutions. This will reduce the time educators spend on, for instance grading exams, assessing homework, and providing valuable responses to their students. For example, in the case of multiple tests AI technology can be utilized to automate the grading tasks thus enabling lecturers or teachers to spend valuable time with students. Additionally, AI can be used to automate school admission board to ensure classification and processing of paper work. Furthermore, the topic of smart content is very critical with regards to education. Robots can however, be used to produce digital content: virtual content like video conferencing, video lectures. Also, AI systems are using traditional syllabuses to create customized textbooks with respect to certain subjects. Consequently, textbooks are now being digitized, and new learning interfaces are being created to aid students of all academic grades and ages. For instance, cram 101 utilizes AI to make textbook contents more comprehensible and this is easy to navigate with summaries of the chapters, flashcards, and practical tests. Another example of AI interface is Netex learning which enables professors/lecturers to create electronic curriculums and educative information across a myriad of devices. It includes online assistance programs, audios, and illustrative videos. The deployment of AI in schools will further facilitate and helps position teachers to perform well by offering individualized recommendation to pupils or students via customization. For instance, in class assignment and final examination will be tailored and this will ensure that each student performs to his or her best ability. AI can also be used to eliminate boundaries by enabling learning from anywhere in the world by equipping students and tutors with the needed IT skills: Thus, AI will improve IT processes as well as help unleashes new competences. For instance, AI can be used by roads and highway authority in Ghana to minimize traffic jams and also improve

upon the safety of pedestrians.

Advantages and disadvantages of using AI in education in rural areas

Tutoring is one of the areas where AI is ready to have extraordinary effect. This innovation can be utilized to computerize essential exercises, such as reviewing tasks, saving time for instructors to perform other significant undertakings, incorporating interactions with students, planning for class, or taking a shot at proficient turn of events.

In like manner, it can offer extra help to students through clever mentoring frameworks and robotized educating operators. Learning difficulties are experienced in various features of instruction. Individualized mentors are generally expected to help students beat these challenges. Nonetheless, because of spending imperatives, the arrangement of individualized mentoring isn't an alternative in certain cases. This is a typical test confronting essential, optional, and tertiary training establishment in Ghana.

Insightful mentoring frameworks can be powerful in giving individualized educational instruction by fitting instructive material to students' needs and by and large helping them work at their own stride. Moreover, they can be utilized to re-skill employees, which will end up being an inexorably significant duty for public and private sector employers.

AI can likewise be utilized to screen student progress and alert educators when there may be an issue with execution, giving valuable criticism on the viability of courses.

In addition, it very well may be utilized to anticipate dropouts and permit scholastic organizations to take sufficient preventive measures. Notwithstanding the various government interventions to make training moderate for all, dropout rates the nation over still stay remain high. This has noteworthy impacts on the societal and economic progress of the nation.

Utilizing AI-based classroom advancements in specific circumstances will help produce factually critical enhancements in students' learning results. For example, grasp and retaining when contrasted with customary study hall education, use of autonomous course reading, and non-AI computer based guidance.

AI innovations may help encourage customized learning (fitting guidance to the necessities of every student) and mixed learning (consolidating innovation with up close and personal association) which will improve scholarly execution and decrease accomplishment breaches between gatherings of students.

The availability of such supplementary educational systems in rural areas will also attract many trained teachers to such areas to facilitate its implementation.

Computer aided intelligence based learning faces critical usage challenges. AI based learning educational plans are somewhat rigid because of specialized difficulties in obliging client input, adjusted fundamental values, or substance changes.

More prominent student autonomy may inconvenience youngsters who are less self-trained or who get minimal instructive help at home, possibly compounding the accomplishment breach. Also, overviews show that a few instructors battle to decipher the information they get from customized learning apparatuses into noteworthy guidance and invest unnecessary measures of energy making individualized tasks. There is additionally banter over how well students hold information gained from an AI-based framework, and in the case of investing significant class energy in computers reduces social learning at school.

The spending ramifications of utilizing AI in instruction are indistinct, given vulnerabilities about the cost viability of the innovation. For instance, the flexibility and versatility of AI may drive a few organizations to reduce teaching staff in favor of AI choices. Conversely, AI may make interest for training experts who can plan and execute customized learning programs.

Challenges of using AI in education in rural areas

Of these, absence of ICT equipment remains the essential boundary in the creating scene. As cell phones are the essential processing gadgets in these zones, absence of programming focusing on these gadgets is a related issue. Data and interchanges innovation have supported remote versatile access over wired admittance (e.g., landlines) in rural areas. Versatile stages for AI conveyance are a developing point in AI exploration; however the limitations of a rural area on information or gadget highlights may introduce unanticipated issues. Practical instructive innovations need to intensely use existing advances, for example, by focusing on versatile stages or through sharing gadgets.

Unstable electrical and Internet framework is a second innovative obstruction. Most rural areas battle with their infrastructure, this issue proceeds in creating territories, especially in rustic regions. All things considered, notwithstanding regular misinterpretations, electrical access is only from time to time an essential barrier. Nonetheless, slow and conflicting Internet framework is a noteworthy issue in numerous zones. Conflicting Internet can be especially vexing for a classroom setting; it is difficult to design an exercise around a conflicting asset.

Also, the experience and points of view on ICT assume a critical part in fruitful adoption. Essential ICT abilities by students are not a main consideration in study hall settings but rather presented significant obstacles for individual ICT use [26]. Classroom-based frameworks, for example, have discovered that absence of essential ICT abilities were alleviated by having just set up computers and peer support. In any case, Gitau et al., found that portable internet client's users confronted genuine obstacles setting up their gadgets for Internet access and required a mix of instructional exercises and client gatherings to arrive at web applications. This implies casual learning conditions might be especially delicate to students' fundamental ICT aptitudes [27,28].

Language boundaries and socially fitting substance were likewise viewed as noteworthy issues. The partitioning lines between these are not in every case totally clear. Language hindrances basically consider syntactics (connections among signs) and semantics (which means of separated signs), which are utilized in

interpretation. Grammar and semantics decide how information is spoken to as instructive substance. From a language point of view, instructive innovation inaccessible in dialects utilized locally for training will be a non-starter. Interpretation incorporates dialects, with additionally different sorts of signs and images. Indeed "self-evident" symbols can be new: at times, youngsters may experience difficulty utilizing programming since symbols might be new in their area. Without adequate earlier information, some theoretical ideas might be difficult to speak to utilizing symbols, for example, a "record" button for recording sound [29].

Challenges to be addressed

Ghana is resolute on its journey towards the goal of integrating ICT in education delivery through the development and integration of persuasive features in ICT tools used in the classroom to enhance teaching and learning. Unfortunately, no remarkable progress and achievement have been made yet. Below are a few challenges that have caused the above mentioned stagnation.

ICT infrastructure

The basis for the effective use of technology in any field of endeavor is the availability of solid ICT infrastructure. Unfortunately, accessibility and availability of internet connectivity is a major issue that has affected Ghana's technological drive. This situation will greatly affect the introduction of smart classroom systems into rural areas.

Finance: Another issue or challenge that needs to be address is the financial challenge. The provision of smart devices as well installation and training will require a huge financial outlay. However, this can be addressed by a collaborative effort between the government of Ghana, UN, UNESCO and other organizations devoted to the education of children.

Implementation: The introduction of smart classroom in the rural areas of Ghana will ensure all inclusive education and development as it will promote and enhance learning experience. The curriculum for basic education in Ghana can be illustrated with the help of photos, maps, graphs, flowcharts, games and animated videos using augmented reality. These tutorials will be done in English and local languages using AI speech translation algorithms. It will also promote interactive learning and ensure that children have a good grasp of the English language using their local language as a basis. Furthermore, such an approach will make learning and teaching fun attractive and easy to understand. The use of applied and cognitive AI as teachers in the rural areas can be piloted in one of the basic schools in one of the 16 regions of Ghana. This will enable proper testing and also evaluation to be done to ensure the proper formulation of policies and strategies for nationwide implementation and hence policies and strategies to be well formulated. Below is a plan for the initial implementation of AI in rural schools (**Figure 1**).

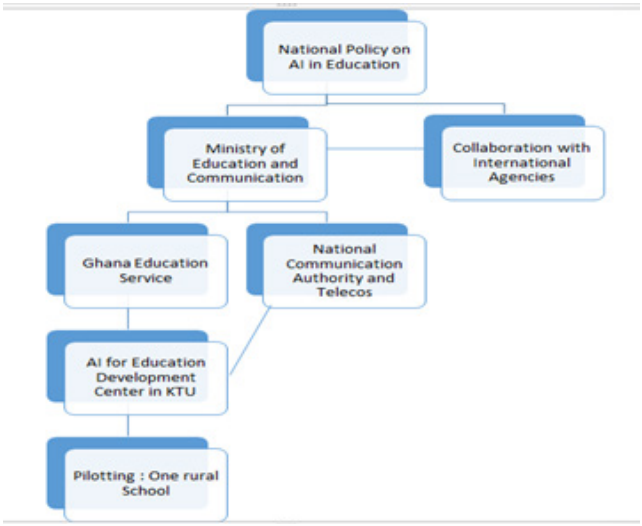

Figure 1: Implementation plan.

Results and Discussion

The fourth aim of the United Nation's Sustainable Development Goals seeks to ensure inclusive and equitable education for all. One of its sub goals speaks directly the upgrading of educational facilities to ensure inclusiveness and equity. The use of AI especially in rural areas in Ghana will go a long way to fulfill this goal. Remarkable progress has been made on what is known as Narrow AI, which addresses specific application areas such as playing strategic games, language translation, self-driving vehicles, and image recognition. Applied AI underpins many commercial services such as trip planning, shopper recommendation systems, and ad targeting, and is finding important applications in medical diagnosis, education, and scientific research. Artificial intelligence can achieve great discoveries and advances for humanity due to its multiple possibilities. Most artificial intelligence systems have the ability to learn, which allows people to improve their performance over time. These have all had significant societal benefits and have contributed to the economic vitality of many nations.

Conclusion

Applied and cognitive AI can be effectively implemented in rural areas as part of Ghana's quest to provide education for all. It is very important to note that such an implementation will help in the overall training of a skilled workforce in the development and use of AI for other varied applications in education and other sectors of the national economy. This bold move will put Ghana ahead as the undisputed leader in the creation of a digitized economy and society.

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