AI in Education:
A Systematic Literature Review

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ABSTRACT

Artificial intelligence (AI) is developing and its application is spreading at an alarming rate, and AI has become part of our daily lives. As a matter of fact, AI has changed the way people learn. However, its adoption in the educational sector has been saddled with challenges and ethical issues. The purpose of this study is to analyze the opportunities, benefits, and challenges of AI in education. A review of available and relevant literature was done using the systematic review method to identify the current research focus and provide an in-depth understanding of AI technology in education for educators and future research directions. Findings showed that AI's adoption in education has advanced in the developed countries and most research became popular within the Industry 4.0 era. Other challenges, as well as recommendations, are discussed in the study.

KEYWORDS

AI, Artificial Intelligence, Education, Ghana Intelligent Tutoring System, Machining Learning

INTRODUCTION

The use of technology in education dates back to the emergence of 1ˢᵗ generation computers and their subsequent updated versions (Schindler et al., 2017). Teachers were seen using computers in teaching, researching, and recording students' grades and in doing other things. Similarly, students, among other things, made use of computers in studying, researching, and solving problems. Also, computers have been used as an educational resource (analogous to a library or laboratory), as well as a means for maintaining databases of student information. (Jones, 1985). The use of technology in education is far advanced with the emergence of artificial intelligence (AI); a system where machines are designed to mimic humans. Artificial Intelligence is "*the science and engineering of making intelligent machines*" or "*a machine that behaves in a way that could be considered intelligent if it was a human being*." (Mccarthy, 2007).

This expression Artificial Intelligence (AI) was first coined by John McCarthy at the Dartmouth Artificial intelligence conference in 1956. Leading researchers from different disciplines converged to discuss topics on the abstraction of content from sensory inputs, the relationship of randomness to creative thinking, and others that developed the concept around "thinking machines". Most participants envisaged the possibility of computers having capabilities to mimic the intelligence of human beings, but their biggest question was how and when it would happen. Currently, Artificial Intelligence is

developing and spreading over every part of the world at an alarming rate (Tegmark, 2015). It plays an increasingly important role in our daily life. As the introduction of AI and Machine learning is catching on with many people, its use in different devices, applications, and services are becoming widespread (Zawacki-Richter et al., 2019). Applications such as Google duplex (chat agent that can carry out specific verbal tasks, such as making a reservation or appointment, over the phone) and FaceApp, which uses AI to identify persons that are tagged in other photos in Facebook are some AI applications and services. Other intelligent appliances such as autonomous vacuum cleaners are examples of AI applications. As indicated earlier, the use of AI in education cannot be overemphasized. Yuki and Sophia the humanoid robot are examples of AI applications in education (Retto, 2017).

AI is broadly categorized into two domains: the weak or domain-specific, which focuses on specific problems; and the strong or general with the ability to perform general intelligent actions. (Berker, 2018). Stephen Hawking's and other researchers have proposed that the use of strong AI may lead to chaos and destruction of mankind, other AI researchers have propounded that the emergence of AI in education might displace teachers. In the context of this paper, we refer to AI as the Soft AI since machines currently have not assumed the capabilities to perform general intelligent actions.

Studies mainly in the Developed Countries have concentrated on challenges in the disruption of AI in Education whiles, the opportunities and benefits of AI in education have received infinitesimal attention. This study is one of the few that provides an integrated overview of the opportunities, benefits, and challenges that Artificial intelligence (AI) adoption presents to the educational discipline. And complementing it with the Technological-Organizational- Environmental (TOE) theoretical framework as a lens in discussing the challenges in AI adoption in Education.

The objective of the study is to analyze the existing state of the art in AI technology in education by investigating the challenges, opportunities, and benefits of adopting AI in education. The study seeks to review relevant studies to understand the current research focus and provide an in-depth understanding of AI technology in education to guide educators and researchers in designing new educational models. The study will also serve as a reference for future research in related works.

This paper is structured as follows: Section 1 presents the introduction and background to the study, followed by section 2 with the state-of-the-art on the types of AI systems in education, the challenges and opportunities, and benefits of AI in education and TOE theoretical framework. Section 3 presents the research methodology for the literature review, then section 4, where discussions of the opportunities, benefit, and challenges of AI adoption based on the literature review will be presented with a discussion of the practical implications of the findings, and finally, section 5, concludes with the future research topic and limitations of the research.

STATE-OF-THE-ART

AI in Education

In the 1960s, the US Department of Defense took an interest in artificial intelligence and began training computers to mimic basic human reasoning. The early work of the Defense Advanced Research Projects Agency (DARPA) marked the beginning of automation and systems that assisted human abilities such as expert systems and smart search systems (Chassignol et al., 2018).

AI has progressed rapidly, not only in fiction with the use of robots to portray AI and human-like characteristics but also AI has evolved to provide many specific benefits in every industry. It encompasses anything from Google's search algorithms to self-driving cars, to autonomous weapons (Tegmark, 2015). Today, AI technology is revolutionizing schools and classrooms and making jobs much easier for educators (Lynch, 2018; Wogu et al., 2019). Over the years there has been a slow but steady revolution in education from using the blackboard to the whiteboard and now the use of projector screens in most educational institutions. Although there has not been a significant advancement in the use of AI in education from the 20th century to date (Dickson,

2017), research has shown steady improvement of AI in education through the use of different virtual assisted applications (Carlson et al., 2018).

Types of AI in Education

Studies (Johnson, 2019; Loeffler, 2018) have shown that AI has become part of our daily lives. AI technology is used in automatic parking systems, smart sensors for taking photos as well as personalized assistance, not forgetting that it has also changed the way people learn. Currently, educational materials have become accessible through smart devices (Johnson, 2019). With the application of AI in educational institutions, several administrative tasks have been automated and others are still being automated to give educators more time to spend on students (Johnson, 2019; Wogu et al., 2019). This section will discuss the different types of transformation AI has brought into education. Although there are other areas influenced by AI, only those that are very relevant to the current topic will be discussed.

- **Automation of Administrative Task**: AI can be applied in the processing of repetitive administrative tasks that will save educators or lecturers from spending long hours in grading and assessing exams and homework respectively (Johnson, 2019). With regards to multiple-choice exams, technology exists that can grade students. However, when it comes to essay-type exams, serious challenges arise as to whether the technology could be employed to award grades. (Johnson, 2019). Software developers are still researching and coming out with ways of grading written answers and essay type questions (Johnson, 2019). Similarly, AI is been used for processing the admission of new students' into educational institutions (Johnson, 2019).
- **Smart Content**: Another AI application in Education is Smart Content. Smart content is an AI technology, which according to Faggella (2019) "attempts to condense textbooks into a useful tool for exam preparation such as true or false". Some examples of some well-known smart content Apps are Cram101 and JustTheFacts101(Faggella, 2019). According to Johnson, (2019), smart content can also include virtual content like video conferencing and video lectures. Cram101 uses AI to make textbook contents more coherent, and it is easy to navigate by introducing chapter summaries, flashcards, and practical tests (Faggella, 2019; Johnson, 2019). There is also a Netex learning AI system that enables the creation of electronic curriculum and educative information(Johnson, 2019). Netex, according to Johnson (2019), "includes online assistance programs, audios, and illustrative videos".
- **Intelligent Tutoring System (ITS)**: According to Faggella (2019), ITS is a human guide and facilitator for use in a variety of educational environments. This area of research has been the goal of AI researchers since the 1970s and 1980s (Faggella, 2019). The idea of self-tutoring was developed by an educational psychologist named Benjamin Bloom in the 1970s. ITS has gained much progress in the research field, and for example, Carniege Learning's "Mike" Software applies cognitive science and AI technologies to create a personalized tutoring system for students (Faggella, 2019; Singh et al., 2018).

Challenges and Opportunities

The use of Artificial Intelligence (AI) in education as seen in Computer-based training (CBT) and Computer-Aided Instruction(CAT), does not provide the same experience as having human teachers in classrooms (Beck et al., 1996). But with continuous research, there are emerging improvements in artificial intelligence in education (AIED) systems. These advancements include the use of user-friendly interface agents like avatars to assist users in language, facial expressions, and issues of identification (Kay, 2012). However, Popenici & Kerr (2017) argued that the aim of technology in education is to increase knowledge and assist teaching and learning but not to compress the process of content delivery, control, and assessment in education. According to the Artificial Intelligence

Market in the U.S education sector report, artificial intelligence is likely to grow by 47.77% from 2018 to 2022 in U.S education. With the growing concern of AI in every aspect of our everyday life, there is no doubt that the most popular Tech company's like Facebook, Google, Apple, and Microsoft continuously invest in the development and research of AI technologies (Gonçalves et al., 2016).

One of the compelling motives for AI adoption in education is the increased number of students from different geographical locations enrolled for courses in higher education given at a central place, coupled with limited funding. This, however, translates into a reduction in the number of teaching staff in most universities with a concomitant reduction in cost (Hollands & Tirthali, 2014; Popenici & Kerr, 2017) Consequently, there is a growing demand for the use of Massive Open Online Courses (MOOC) as an opportunity for distance learning with the support of technology. MOOCs are open courses that are made available on the net for a very high number of participants, usually, with no or less fees from participants (Gonçalves et al., 2016) The use of Teacherbots (computing solutions for the administrative part of teaching, dealing with content delivery and administrative feedback and supervision) and IBM Watson (question and answer computer system that uses natural language to answer questions posed by a user) are some AI applications that are available to enhance teaching and learning(Gonçalves et al., 2016).

Despite these new technological innovations in education, studies Bayne (2015) and Botrel et al. (2015) are of the view that the use of teacher bot and other intelligent applications that mimic human intelligence in education is meant to displace teachers (Bayne, 2015; Botrel et al., 2015). On the other hand, the internet society reported that AI can create new jobs and/ or increase demand for certain existing ones (Internet Society, 2017). Moreover, the focus of most AI applications currently is on machine learning which does not require programming but rather the application uses inferences to learn and adapt to users' trends(Internet Society, 2017). In this situation, data becomes the most valuable resource for AI implementation and continuity. This also suggests that privacy, trust, ethics, and other socio-economic issues must be taken into consideration when implementing AI in education. (Internet Society, 2017).

THEORETICAL FRAMEWORK

The study adopted the Technological - Organisational - Environmental (TOE) framework as proposed by Tornatzky and Fleischer's (1990) as a lens in discussing the challenges of adopting Artificial Intelligence in Education (Tornatzky et al., 1990). The framework presents the factors that impact on technological innovation in three contexts: Technological, Organizational, and Environmental context (Baker, 2012).

The TOE developed by Depietro, Wiarda, and Fleischer (1990) is argued to be an integrated framework that provides a theoretical basis for IT adoption/diffusion research. It examines the various technological, organizational, and environmental factors that influence the adoption of IT innovations (Bernroider & Schmöllerl, 2013). TOE is considered to be an organizational level theory that is used to explain three factors that influence adoption decisions (Baker, 2012). As shown in figure 1, the framework posit that an organization/firm's decision to adopt an innovation is dependent on these factors; technology, organization, and environment (Bernroider & Schmöllerl, 2013; Olutoyin & Flowerday, 2015). Even though TOE has been used in several studies to explain IT innovation adoptions such us mobile supply chain (Chan & Chong, 2013), green IT (Bose & Luo, 2012), E-business (Oliveira & Martins, 2010), Cloud computing (Abdollahzadegan et al., 2013), etc., its application in AI adoption in education is scanty. The TOE framework is claimed to be a generic theory for technology adoption/diffusion (Zhu et al., 2006), and its main goal is to explain and determine organization's decision making in adopting IT innovations and its diffusion (Song et al., 2017), hence it can be used to study the challenges in adopting AI in education.

Figure 1. Technology-Organisation-Environment Framework ((Depietro, R., et al., 1990)
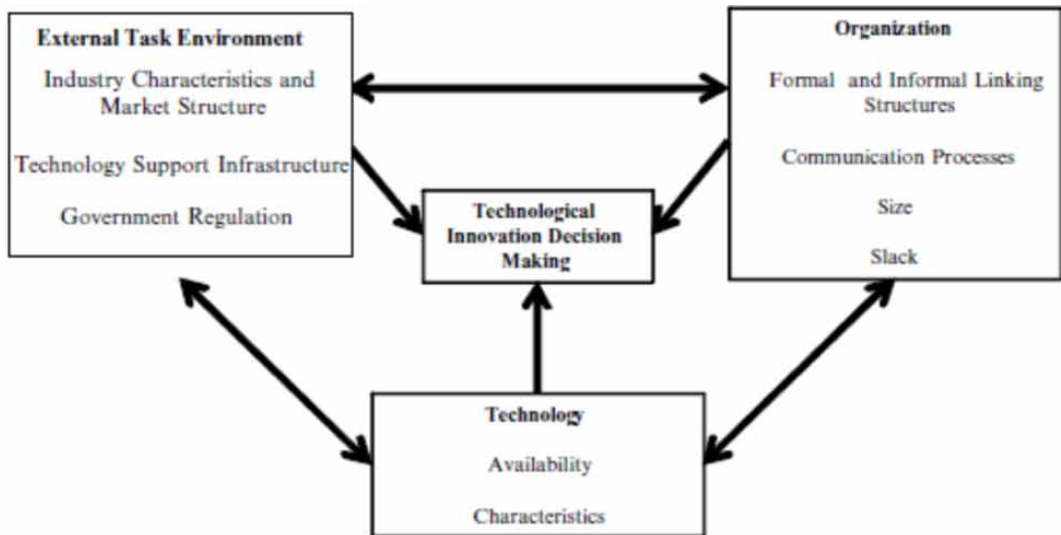
Technological Context

The Technological context includes technologies that are either in use or those that are available in the market but not in use currently (Baker, 2012). Thus, it concentrates on innovations that are within and outside the firm. Innovations outside the firm are further grouped into incremental change and synthetic change. The incremental change represents the upgrading of existing technologies or new versions that are released. The synthetic change represents an improved use of existing technology which is not necessarily an innovation, and discontinuous change, on the other hand, it represents new technologies (Baker, 2012; Tushman & Nadler, 1986). Technology refers to the internal and external technologies relevant to the firm. This also includes the current technologies and the internal infrastructure available within an organization or company (Martins et al., 2016) as well as those available at the market place but not available within the organization or firm (Baker, 2012). This technology may include equipment processes and techniques (Depietro et al., 1990). The study, Baker (2012) argues that technologies that are available to a firm are very important to the adoption process, this is because it sets the limit for the scope of change that can happen within the organization. Similarly, an innovation that exists outside the firms also influences the adoption process, because it defines the limit to what is possible and helps the firm to understand how technology can assist them. This technological context has an impact on IT innovation adoption and the major factors in this regard include the cost of procurement, maintenance and existing human expertise within the firm to use the IT innovation.

Organizational Context

Organizational context relates to the available resources and characteristics of the firm such as the structure of the firm, the communication process, organizational readiness, and size of the firm (Agbesi, 2020; Baker, 2012). Organization refers to the organizational attributes of the firm or institution such as its scope and size, organizational managerial structure, it's human resources, linking structures between employees, intra-firm communication processes, and the number of slack resources (Depietro et al., 1990; Martins et al., 2016; Olutoyin & Flowerday, 2015). Within the organizational context, Top management support, organizational readiness, ICT experience, and size are considered to be some of the main organizational factors that influence IT innovation adoptions

(Ramdani et al., 2013). Zhu, Kraemer, Kenneth & Dedrick (2004) explain that factors like the firm size, global scope, and financial resources have an impact on innovation adoptions. Previous studies identify Top management support to be an important factor that positively influences the adoption of IT innovation (Martins et al., 2016).

Environmental Context

Environmental context represents the factors that can drive or constrain innovation such as the structure of the industry, support structure for technology, government regulations, cultural issues, and pressure from stakeholders (Baker, 2012). Depietro, et al. (1990) describe environmental context to include the size and structure of the organization, its competitors, and the regulatory environment. The environmental context describes the surroundings or the arena in which the organization operates and conducts business. These surroundings include other industries and competitors. Baker (2012) argues that support infrastructure for technology also has an impact on innovation, and organizations that have to pay higher salaries for skilled labor are compelled to look for other alternative innovations. Similarly, the availability of skilled labor and the availability of technology vendors have a positive influence on organizations' decision or intent to adopt an innovation (Baker, 2012).

How Earlier Researchers Used TOE Model in Previous Studies

Leung, Lo, Fong, & Law (2015), studied the application of TOE to explore the ICT initial and continue adoption in hotels in Hong Kong using exploratory design. The main aim of the study was to examine the factors affecting ICT initial adoption and continue adoption decisions of an independent hotel and to develop a framework. The following variables were measured. 1) Technological Context: Expected direct benefit, Expected indirect benefit, Cross technological compatibility, and Expected risk. 2) Organizational Context: Financial readiness, Technological readiness, and Top management support. 3) Environmental Context: Perceived pressure from partners, and Perceived pressure from customers. Similarly, Alshamaila, Papagiannidis, & Li (2013) studied cloud computing adoption in the North East of England by adopting the TOE framework as the theoretical base. Using a qualitative exploratory study (Alshamaila et al., 2013) collected data from 15 SMEs and service providers from North East England. The result of the findings indicates relative advantage, uncertainty, geo-restriction, compatibility, trialability, size, top management support, prior experience, innovativeness, industry, market scope, supplier efforts, and external computing support are the main significant factors influencing SME's adoption of cloud computing services. Zhu, Kraemer, & Xu (2004) also studied E-business adoption by European firms using TOE as a framework. The main purpose of the study was to examine whether adoption patterns differ across different e-business environments and to develop a conceptual model to study the adoption of electronic business at the firm level, by incorporating six adoption facilitators and inhibitors, based on the technology–organization–environment theoretical framework. The results of the findings showed that Technology competence, firm scope and size, consumer readiness, and competitive pressure are significant adoption drivers, but lack of trading partner readiness is a significant adoption inhibitor. Faber, Geenhuizen, and Reuver (2017) also researched eHealth adoption in medical hospitals in the Netherlands. The main purpose of the study was to develop and test the eHealth adoption framework to get a detailed understanding of the phenomenon. The result of the study shows that the size of the hospital, organizational readiness including technical aspects, and top management support have a significant effect on adoption decisions. Song et al. (2017) also applied TOE to examine the decision-making process of lodging firms in the adoption of Online Third-Party Intermediaries (OTPIs) for distribution services on the internet. The song model was based on a combined Technology–Organization–Environment framework (TOE) and an Expectation–Confirmation Model (ECM). The study used survey design using closed-ended questions in data gathering. The population of the study was 215 general managers and owners in Greek Island with 37 respondents. Partial Least-Square-Structural equation model was used for the data analysis. The results of the findings show that the organization has significant impacts on

confirmation in ECM and the environment in TOE significantly influences satisfaction in ECM, and both confirmation and satisfaction are antecedents of continuance intention.

The Use of the TOE Framework in Current Study

In the context of this research, TOE is used in the discussion of the challenges in the adoption of Artificial intelligence in education. Concerning the technological context, challenges about existing technology, and other available new technologies that can be adapted are discussed. The study would discuss the challenges in an organizational context with organizational readiness, the firm structure, and availability of the requisite infrastructure in the use of artificial intelligence and its impact on Education. The requisite skillset of staff and infrastructure are important factors to consider in the adoption of new technology since they are considered the driving force for successful implementation. The Environmental context will focus on the ethical and socio-economic issues in the adoption and implementation of artificial intelligence in Education. TOE framework provides us with the appropriate construct to examine these factors that influence an organization's adoption of innovation and in this instance, AI in Education.

METHODOLOGY

This section presents the method used in obtaining the literature for the study. Following the purpose of this study, the rigorous evidence-focused review model proposed by Hagen-Zanker and Mallett (2013) was adopted. The rigorous, evidence-focused review is a form of systematic review method which is suitable if there is time constrain in development studies (Hagen-Zanker & Mallett, 2013). This section follows the outline of the rigorous evidence-focused review proposed by Hagen-Zanker and Mallet (2013). The goal of this study is to explore the challenges, opportunities, and benefits of Artificial intelligence in Education (AIED) discipline from the existing historical trends. To achieve this, the research questions were framed: *What are the opportunities, benefits, and challenges of AI adoption in education? What is the geographical area that Artificial intelligence research is concentrated on?*

The search term/key was generated from the main objectives. The key terms used for the search as shown in table 1, were as follows: Artificial intelligence, education, intelligent tutoring system, adoption, opportunities, benefits, and challenges. Articles were searched in electronic databases such as Science Direct, IEEE Explorer, Web of Science, ProQuest, and Springer Link.

Then the title, abstract, and keywords were used to search published articles, journal papers, conference proceedings, workshops, and symposiums. The study made use of both forward and

Table 1. Search strings

Topic	Search Terms
Artificial Intelligence **AND** **Factors** **AND** **Other factors**	"AI" OR "ai" OR "Artificial Intelligence" OR "artificial intelligence" OR "ARTIFICIAL INTELLIGENCE" OR "Intelligent Tutoring System" Trust OR trust OR Risk OR risk OR "Trust Perceptions" OR "trust perceptions" "Trust Perception" OR "trust Perception" OR "Risk Perceptions" OR "risk perceptions" OR "Risk Perception" OR "risk perception" OR "Adoption" OR "ADOPTION" OR "USE" OR "Use" OR "Implementation" OR "IMPLEMENTATION" OR "Acceptance" OR "ACCEPTANCE" OR Education OR EDUCATION Challenges OR CHALLENGES OR Benefits OR BENEFITS OR Opportunities OR OPPORTUNITIES

backward snowballing search approach to complement the systematic review method. The advantage of snowballing is using references or citations of an article as a guide to identifying other references (Wohlin, 2014). When using a snowballing approach, one does not only benefit from the papers or articles but also from their references and citations as well. The literature search resulted in 215 articles as of June 2019. The criteria used for the articles to be included, as shown in Table 2, were based on the following factors: focus on articles about the subject of the research, articles published from 2010 to 2019 in peer-reviewed journals and conference proceedings, articles written in English, and studies based on both qualitative and quantitative methods.

Table 2. Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Peer-reviewed **Publication: 2010 to 2019** **Publication in the English Language** **Journal Articles** **Conference Proceedings** **Qualitative and quantitative studies**	Publications before 2009 Not Published in English

After screening the article set was narrowed down to 25 articles. Abstract of all 25 eligible publications were manually read to ascertain the relevance of the articles to the subject focus of the literature review. An evaluation based on full text reading further reduced the articles to 23 articles. Afterward, articles were synthesized based on the following: year of publication, author name, the title of the paper, research purpose, method and type, and geographical coverage. The discussions were categorized and presented as opportunities, benefits, and challenges of AI. TOE was used in the discussion of the challenges in the adoption of Artificial intelligence in education. The technological context discusses challenges about existing technology and other available new technologies that can be adapted. The challenges in an organizational context focused on organizational readiness, the firm structure, and availability of the requisite infrastructure in the use of artificial intelligence and its impact on Education. Then the Environmental context focused on the ethical and socio-economic issues in the adoption and implementation of artificial intelligence in Education. The full list of the selected articles is presented in Table 3.

RESULTS

This section presents the results of the literature review. A descriptive overview of the selected articles is presented. Then the opportunities, benefits, and challenges, found in the selected articles are discussed.

These papers obtained were published in either journals or conference papers. Overall, twenty-three (23) articles were reviewed from these years: 2010(1), 2012(1), 2014(1), 2015(1), 2016 (4), 2017(4), 2018(6), and 2019(5). These years were selected to present a range that will reflect on how AI has evolved and its impact on education in the era of industry4.0. Studies have established that there were fewer studies on AI before 2010 and thereafter research increased as new Technologies began to adopt AI more frequently as the primary key enabling Technology in the fourth industrial revolution (Duan et al., 2019).

All 23 articles were related to the subject focus which is Artificial Intelligence in Education in which 15 articles were published in scientific journals and 8 were recorded in the conference proceedings. Also, the number of articles increased simultaneously with the years. The years 2010,

Table 3. List of selected articles

Year	Author(s)	Title	Research Purpose	Method	Type	Context
2019	Connell & Black	*Artificial Intelligence and Legal Education. Computer & Internet Lawyer*	Challenges of AI in education	Exploration	Journal	Developed country
2019	Latham & Goltz	*A Survey of the General Public's Views on the Ethics of Using AI in Education*	challenges of AI in education	Exploration	Conference paper	Developed country
2019	Guilherme	*AI and education: the importance of teacher and student relations*	Benefit of Artificial intelligence	Exploration	Journal	Developed country
2019	Everett	*Is it too soon for AI in the classroom?*	challenges of AI in education	Concept	Journal	Developed country
2019	Florea & Radu	*Artificial Intelligence and Education*	Benefits of AI adoption in Education	Concept	Conference paper	Developed country
2018	Lin, Wooders, Wang, & Yuan	*Artificial Intelligence, the Missing Piece of Online Education?*	Opportunities of AI adoption in Education	Design	Journal	Developed country
2018	Ciolacu, Tehrani, Binder, & Svasta,	*Education 4.0-Artificial Intelligence Assisted Higher Education: Early recognition System with Machine Learning to support Students' Success.*	Benefits of AI	Design	Conference paper	Developed country
2018	Pierce & Hathaway	*The Promise (And Pitfalls) Of AI For Education*	Challenges of AI in education	Perspective	Journal	Developed Country
2018	Sijing & Lan	*Artificial Intelligence Education Ethical Problems and Solutions*	Challenges in AI education	Perspective	Conference paper	Developed country
2018	Carlson, Evans & Hardin	*AI, Education and the Future of Everything*	Challenges of AI in education	Perspective	Journal	Developed country
2018	Zhao, Li, & Feng	*Research on Application of Artificial Intelligence in Medical Education*	Opportunities in AI adoption in Education	Exploration	Journal	Developed country
2017	Price & Flach	*Computational Support for Academic Peer Review: A Perspective from Artificial Intelligence.*	Opportunities in AI adoption in Education	Perspective	Journal	Developed country
2017	Hoeschl, Bueno, & Hoeschl	*Fourth Industrial Revolution and the future of Engineering: Could Robots Replace Human Jobs?*	Challenges of AI in Educcation	Design	Journal	Developed country
2017	Internet Society (Gahnberg & Polk)	*Artificial Intelligence and Machine Learning*	Benefit of AI in education	Concept	Journal	Developed country
2017	Popenici & Kerr	*Exploring the impact of artificial intelligence on teaching and learning in higher education*	Challenges of AI in education	Concept	Conference paper	Developed country
2016	Kandlhofer, Steinbauer, Hirschmugl-Gaisch, & Huber	*Artificial intelligence and computer science in education: From kindergarten to university*	Benefit of AI	Concept	Conference paper	Developed Country
2016	Aleven, Roll, McLaren, & Koedinger	*Help Helps, But Only So Much: Research on Help Seeking with Intelligent Tutoring Systems*	Opportunities in AI adoption in Education	Concept	Journal	Developed country

Table 3. Continued

Year	Author(s)	Title	Research Purpose	Method	Type	Context
2016	Roll & Wylie	*Evolution and Revolution in Artificial Intelligence in Education*	Opportunities in AI adoption in Education	Perspective	Journal	Developed country
2016	Du Boulay	*Artificial Intelligence as an Effective Classroom Assistant*	Benefit of AI in education	Concept	Journal	Developed country
2015	Potode & Manjare	*E-Learning Using Artificial Intelligence*	Benefit of AI in education	Concept	Journal	Developed Country
2014	Conklin & Hartman	*Appreciative Inquiry and Autonomy-Supportive Classes in Business Education*	Bpportunities in AI adoption in Education	Concept	Journal	Developed country
2012	Kay	*AI and Education: Grand Challenge*	Challenges of AI in education	Perspective	Conference paper	Developed Country
2010	Li, Zhuying, & Bing	*The Application of AI Technology in Intelligent Tutoring System*	Benefit of AI in education	Concept	Conference paper	Developed country

2012, 2014, and 2015 recorded one (1) article each, four (4) articles was published in 2016 and 2017, whereas six(6) and five(5) articles were published in 2018 and 2019 respectively. This indicates the gradual and steady pace of research in AI application in education, as suggested by Dickson (2017) who asserts although there has been a steady improvement in the adoption of technology in education not much significant advancement has been noticed in the use of AI in education from the 20th century to date. On Geographical coverage, all 23 published articles were studies conducted within the context of developed countries and no publication was found on the use of AI in Education in the context of developing countries. This suggests that the focus of AI use in education in developing countries has not commenced or still at an early stage.

On the methods, most published articles analyzed data using qualitative more than the quantitative methods. 10 articles employed a proof of concept method to evaluate the AI systems that are used in education, Six (6) articles analyzed user perception of trust in AI and computer agent application implementation in education. Four (4) of the articles explored the use of AI in education and other sectors whereas three (3) articles designed computer models and robots to perform actual task and results were evaluated. A single study used the survey to explore the ethical and legal issues from public views on the AI in education and the result indicated that 77% of participant express worry in its implementation in learning systems whereas fewer than 8% were dissatisfied about been tracked (Latham & Goltz, 2019).

DISCUSSIONS

This section discussed results in selected articles based on opportunities, benefits, and challenges of AI in education and the methods used in conducting the studies. The paper is analyzed along the following dimensions; opportunities (6), benefits (8), and challenges (9) of AI in education. The study further analyzed the challenges using the Technological, Organizational, and Environmental (TOE) framework and also discuss some ethical issues in AI.

Opportunities in AI

The use of AI has proved to be a viable method for creating a meaningful learning experience for students (Conklin & Hartman, 2014). Under opportunities of AI, there were six (6) articles which the study categorized under methods with the following descriptions: concept, design, exploratory, and perspective. The author further classified each paper by the focus of its main purpose, method, year, and outcome of the research. Two (2) studies (Aleven et al., 2016; Conklin & Hartman, 2014)

addressed opportunities based on concept approach and indicated that Intelligent tutoring systems (ITS) provides better feedback or tutoring for the student but does not provide a better environment for self-regulated learners (Self-regulation of academic learning is the control that students have over their cognition, behavior, emotions, and motivation through the use of personal strategies to archive goals they have established). Another method based on the use of Robots in the design approach resulted in the students' achieving their learning outcome with the help of the trained Robot (Lin et al., 2018). Based on the perspective, two articles were analyzed. One explored the strength and opportunities of AI in education by way of evolutional and revolution processes (Roll & Wylie, 2016). Whiles the other perceived the improvement of the peer review process using computational support (Price & Flach, 2017). A single article discovered improved efficiency in medical teaching and serving people with the use of AI as a great opportunity that can influence the adoption of AI technology in the medical field (Zhao et al., 2018). A list of articles on AI opportunities in Education is presented in table 4.

Table 4. List of AI opportunities articles

Author	Title	Year	Method
Lin, Wooders, Wang, & Yuan	*Artificial Intelligence, the Missing Piece of Online Education?*	2018	Design
Zhao, Li, & Feng	*Research on Application of Artificial Intelligence in Medical Education*	2017	Exploration
Price & Flach	*Computational Support for Academic Peer Review: A Perspective from Artificial Intelligence.*	2017	Perspective
Aleven, Roll, McLaren, & Koedinger	*Help Helps, But Only So Much: Research on Help Seeking with Intelligent Tutoring Systems*	2016	Concept
Roll & Wylie	*Evolution and Revolution in Artificial Intelligence in Education*	2016	Perspective
Conklin & Hartman	*Appreciative Inquiry and Autonomy-Supportive Classes in Business Education*	2015	Design

There has been a noticeable increase in research on opportunities in AI in education between 2015 to 2018. And most of the research work is based on the design and perceptive approach. However, studies based on a design science approach usually place no attention to the socio-economic factors of AI adoption in education.

Benefit

The next category of analysis is based on the benefits of AI in education as presented by literature. Eight (8) articles were analyzed along with the following descriptions: concept, design, exploration, and perspective. The papers were further classified according to their main purpose, method, and outcome. On articles classified according to methods, most articles were based on a concept, only a single article employed design method. A single paper provided proof on how AI in education, (using AI concept) in different educational levels (primary, middle, high and tertiary schools) worked. This

was achieved through the development of AI-related courses such as games to facilitate teaching and learning. (Kandlhofer et al., 2016). Whiles the other three studies elaborated on the assessment of effective classroom assistance such as the Intelligent Tutoring System (ITS). Du Boulay (2016) conducted a review on different Pedagogical models and concluded that "AIED systems perform better than both computer-assisted instruction (CAI) systems and human teachers working in large classes. They perform slightly worse than one-on-one human tutors." Studies (Li et al., 2010; Potode & Manjare, 2015) analyzed different structures and functions of ITS and new developmental trends. The former resolved that ITS conduct their teaching function effectively, while the latter resulted that ITS promote collaborative learning and improve student's motivation and learning. A single study developed a personalized learning environment created with Auto tutoring to monitor students' performance using wearable devices and smart sensors. The study argued that an early detection system provided an unbiased view of student performance (Ciolacu et al., 2019). A list of articles on AI benefits in Education is presented in table 5.

Table 5. List of AI benefits articles

Author	Title	Year	Method
Guilherme	*AI and education: the importance of teacher and student relations*	2019	Exploration
Florea & Radu	*Artificial Intelligence and Education*	2019	Concept
Ciolacu, Tehrani, Binder, & Svasta,	*Education 4.0-Artificial Intelligence Assisted Higher Education: Early recognition System with Machine Learning to support Students' Success*	2018	Design
Internet Society (Gahnberg & Polk)	*Artificial Intelligence and Machine Learning*	2017	Concept
Hoeschl, Bueno, & Hoeschl	*Fourth Industrial Revolution and the future of Engineering: Could Robots Replace Human Jobs?*	2017	Design
Kandlhofer, Steinbauer, Hirschmugl-Gaisch, & Huber	*Artificial intelligence and computer science in education: From kindergarten to university*	2016	Concept
Du Boulay	*Artificial Intelligence as an Effective Classroom Assistant*	2016	Concept
Potode & Manjare	*E-Learning Using Artificial Intelligence*	2015	Concept
Li, Zhuying, & Bing	*The Application of AI Technology in Intelligent Tutoring System*	2010	Concept

Most Studies commend that AI presents the advantage of creating new jobs and also increasing demand for certain existing ones (Internet Society, 2017). This suggests that most articles on benefits concentrate on a concept with limited design artifact to prove the unbiased performance of an AI

system in Education and also to ensure trust in its use. Therefore, the need for more empirical studies may be required to analyze actual user data that may intensify the benefits of AI in education.

Challenges in AI

This section presents the challenges of AI adoption in Education by using the TOE theoretical framework as a guide in the discussion.

Nine (9) articles were analyzed using the Technological, Organizational, and Environmental (TOE) framework and discuss some ethical issues in AI. Each paper was further classified by its main purpose, method, and outcome. A list of articles on AI challenges in Education is presented in table 6.

Table 6. List of challenges in AI

Author	Title	Year	Method
Connell & Black	*Artificial Intelligence and Legal Education. Computer & Internet Lawyer*	2019	Exploration
Latham & Goltz	*A Survey of the General Public's Views on the Ethics of Using AI in Education*	2019	Exploration
Everett	*Is it too soon for AI in the classroom?*	2019	Concept
Pierce & Hathaway	*The Promise (And Pitfalls) Of AI For Education*	2018	Perspective
Sijing & Lan	*Artificial Intelligence Education Ethical Problems and Solutions*	2018	Perspective
Carlson, Evans & Hardin	*AI, Education and the Future of Everything*	2018	Perspective
Popenici & Kerr	*Exploring the impact of artificial intelligence on teaching and learning in higher education*	2017	Concept
Kay	*AI and Education: Grand Challenge*	2012	Perspective

Technological

This section discussed an empirical study on emerging architecture for AIED systems and the drivers that influence the creation of AIED systems. Those factors that drive the AIED system and the AIED structure. First, it was observed that the principal factors influencing AIED research are Educational needs, which as a result generates AI theories, tools, and techniques. Scholars discussed the four core elements of AIED: a model of the learner, domain expertise, teaching expertise, and interfaces. The goal of the AIED/ITS system is geared towards the individual learner. However, in recent years, advancement in a broader learning context is encouraged with the inclusion of other parties such as teachers and parents. Moreover, data is needed in creating a group learning environment but data sharing poses a serious challenge which gives rise to machine learning and educational data mining communities (Kay, 2012). The study Pierce and Hathaway (2018) state that data is important in creating an effective AI system. The study further stressed that inaccurate or incomplete data in AI technology may affect decisions or outcomes made by the system; since decisions made depend largely on the knowledge domain of the systems. Another challenge is the use of the wrong technology in the design of adaptive learning systems. Vendors must be probed enough to ensure that their systems use machine learning technology and not any other alternate technology. (Pierce & Hathaway, 2018).

AI technology raises some privacy concerns with the focus on information ownership. The use of AI in education requires the collection of sensitive information like student academic records and

performance assessment data. Also, the current use of GoGuardian student's which is used to report unauthorized content and materials that student access over the internet to their administrators records sensitive information about students. The issue is, who has custody of the data and how the integrity and privacy of such data are assured. (Pierce & Hathaway, 2018). Technological challenges identified data ownership, technology, security, and trust as challenges of AI adoption in Education and these factors dominated the articles on the challenges.

Consequently, Educators and policymakers must address ownership of information and data privacy issues in AIED by formulating data protection policies to guide the integrity of data in an attempt to adopt AI. The use of new and existing technology is dependant on the trust of the system however most research failed to mention the paradigm shift in the underlying design of the AI system, thus from algorithm base to machine learning, deep learning, neural science, etc. which requires the use of the appropriate technology to construct.

Organizational

This section discusses the challenges in an organizational context with organizational readiness, the firm structure, and availability of the requisite infrastructure in the use of artificial intelligence and its impact on education.

A recent study by Connel & Black suggested that changes in technology have impacted organizations differently, and the legal profession is not exempt from the use of AI in their practice. (Connell & Black, 2019). The study made mention of ROSS intelligence and other web sites that make use of AI applications in the legal profession by offering self-guided programs. However, there is growing concern that technology will replace lawyers. Research has indicated that there has been a tremendous decline in law school enrolment since 2010 which has resulted in the merging and closure of some Law Schools. Because of the perception that lower rung legal functions (such as legal research, basic memo checking, legal discovery and drafting of cases) that are traditionally done by new lawyers, will be taken over by machines. The study recommended a curriculum review in law school to include AI technology as a research tool for up and coming lawyers (Connell & Black, 2019). Based on the evolution of technology in the Engineering field, Milena et al, (2017) discussed some ethical issues raised by industry regulator bodies. The said ethical issues focused on AI education in Engineering and its impact on Society and Technology. Some of the ethical principles raised were to make users the center of the technology; greater result in AI can be achieved if it addresses most of the user needs. Challenges related to organizational challenges of AI in education were identified as the structure of the institution however it's been argued that The technology has changed: A lot of the tools and processes have been digitized, some of it has been automated, and geographical barriers have been removed to some extent but the actors and elements have remained much the same (Dickson, 2017). This indicates how education remains a social interaction discipline even with the introduction of AI.

Environmental

This section discusses challenges based on environmental context with a focus on the ethical and socio-economic issues in the implementation of artificial intelligence in Education.

Sijing & Lan (2018) researched into the ethical problems and solutions regarding Artificial intelligence in Education. The findings showed that people are the main problem of AI in education and not the technology itself. The study further categorized people into programmers: who design the AI system, students: who use the AI system, and teachers: who use the AI system. With the view to providing solutions to the ethical issues raised about AI, the study recommended the following: Programmers must incorporate the legitimacy and right of humans in the design of AI algorithms. Students are required to take part in ethical courses to be guided in the use of AI technology. Teachers must guide students in making an informed decision about the use of technology for social development and AI, and also update themselves in the use of AI technology. The study identified

a necessary issue thus, legitimacy and human right which must be taken into consideration in the adoption of AI in education.

Another study based on a design system also raised a serious issue that the advancement in AI may cause loss of jobs in the shortest possible time. The study compared the problem-solving capabilities of humans and machines and the result indicated that machines have higher capabilities in mathematics and calculus than humans. This was confirmed as an AI robot passed the entrance examination of some universities in Japan (Arai & Matsuzaki, 2015).

Informed by AI's ability to displace teachers, study Popenici and Kerr (2017) argued that AI can enhance the structural procedures in education but AI is not yet a ready solution to replace teachers as there have been documented limits in the use of the technology in other sectors. For example, the AI-powered vehicle on autopilot was unable to detect a vehicle and run into it which led to the death of the driver in May 2016 (Shepardson, 2017). Also, the use of Tay, an artificial intelligent chatbot designed by Microsoft as a machine learning project for human engagement failed when it sounded racist in response to user's questions on twitter. Tay was taken offline by Microsoft due to its inappropriate responses to users online (Tennery & Cherelus, 2016).

Another ethical issue raised by literature is accountability. If issues come up in AI systems how is it addressed? For example, who oversees data and if data leaks who is held responsible. What if the AI system does not assess students fairly in exams? (Everett, 2019). Most articles identified similar environmental challenges such as job displacement, biases in AI assessment, legitimacy, and human right as the challenges in AI adoption in Education. Articles on environmental factors and technological factors dominated the challenges of AI in education. Inferring from the studies most institutions are prepared to adopt AI technology, however, cost, choice of technology, and ethical issues are hindering the adoption of AI in education.

CONCLUSION AND FUTURE RESEARCH

Numerous publications highlight the application of AI implementation but the ones that specifically present the relation between opportunities, benefits, and challenges in education are still fragmented and scarce. From the findings, AI opportunities provide a clear indication of how AI can impact positively on education. Some opportunities for students is by engaging them in collaborative learning and to the teachers by relieving them off extra duties such as administrative and marking of exams. This, in turn, enables teachers and educators to make time for research and increase contact hours with students who require that. On the question of benefits, most research concentrated on the use of ITS and its function. The study discovered that there is not much available research on alternative AI applications in education besides ITS which has much popularity in education. This, however, will limit the flexibility of educators to make an informed decision about which AI system to adopt and its associated benefits.

The findings showed that academic research in AI in education was fewer from 2010 to 2015, however, advance research commenced from 2016 to 2019, with most of the literature obtained from 2018. Majority of studies focused on the challenges in adopting AI in Education while opportunities and benefits recorded quite appreciable numbers. This suggests an increase in research in the area of AI and its impact on education in the period where the world is digitizing most processes. Existing literature shows that AI in education is already in use in education and other sectors in developed countries. It creates vast opportunities in education for both teachers and students to utilize and achieve its needed benefits. To benefit from the opportunities, the study proposed a more intensive and designed based research approach to come out with an alternate AI system in education to inform and assist decision-makers and educators in choosing the preferred systems.

Contemporary research shows that there have been enormous studies on the challenges in adopting AI in education, but none utilize the TOE framework as a guide. This study, however, adopted the TOE framework as a guide in the discussion of the challenges in adopting AI in

education. Environmental factors such as ethical issues, recorded majority of the discussion in this domain, followed by Technological factors like use and ownership of data, and last but not the least Organizational factors like AI replacing humans. The findings indicate that AI in education is already implemented and in use in education, in the United States of America, Japan, and other Developed Countries. The recommendation is that there is a need to formulate policies to control and guide the use of technology to ensure an effective and efficient outcome. For instance, ethical issues caused by an AI system should be addressed by the laid down policies and standards, which identifies who is responsible for the information used by the system. An approach to incorporate accountability in the use of AI in education would be a starting point to solve the ethical problems in AI. The study also proposed further empirical studies of ethical issues in AI to address the socio-economic issues associated with its adoption in Education in Developing Countries.

Research into a new domain of AI in education must be intensified. Educators must revise the educational curriculum at various levels (primary, secondary, and tertiary) to instill in students the foundational knowledge to create or build AI applications and ensure sustainability in AI. Educators and researchers should continuously upgrade themselves in new applications in AI, to guide students in making an ethical decision about the use of such systems.

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