

REVOLUTIONALISING EDUCATION: LEVERAGING ARTIFICIAL INTELLIGENCE AND PERSONALIZED LEARNING

Nkwocha Stella Ekwutosi Ph.D¹, Ikwen, Simeon Akashie² and Nkwocha Okechukwu Chimbuchi³

^{1,2}Department of Curriculum and Instruction,

^{1,2}Federal College of Education, Obudu. Cross River State.

³Department of Cyber security, MIVA University Abuja

Abstract

Education is undergoing a profound transformation, and the marriage of personalized learning with artificial intelligence is at the forefront of this revolution. The dynamic synergy between these two forces is reshaping the educational landscape, offering students tailored learning experiences that cater to their individual needs. Artificial Intelligence (AI) integration has become a transformative force in the ever-changing field of education, especially in the area of personalized learning. It is essential to embrace the potential of AI as a tool that empowers both educators and learners, fostering a more inclusive, engaging, and effective educational journey for all. Personalized learning recognizes that each student is unique, with distinct learning preferences, strengths, and areas that require more attention. This paper explores how AI technologies, such as adaptive learning platforms, predictive analytics, and intelligent tutoring systems contribute to more equitable and efficient education, emphasizing the potential of inclusive access to AI tools and highlights the role of technology in democratizing education globally. The research concludes with recommendations for integrating AI into educational practices to ensure broad and equitable impacts.

Keywords: personalized learning; artificial intelligence; adaptive learning platforms; predictive analytics; intelligent tutoring systems; educational equity

Introduction

The integration of Artificial Intelligence (AI) in education has ushered in a transformative era, redefining traditional teaching and learning methods. The synergy between AI and education promises to address individualized needs, enhance student engagement, and optimize learning outcomes. Personalized learning, enabled by AI algorithms, tailors educational experiences to the unique needs, preferences, and pace of each student. Introduction The advent of Artificial Intelligence (AI) in education marks a transformative shift in learning delivery, assessment, and personalization. Traditional one-size-fits-all approaches to education often fail to accommodate the diverse learning needs of students, leading to disparities in academic achievement (Luckin, Holmes, Griffiths, & Forcier, 2016). AI-powered personalized learning offers tailored educational experiences by leveraging data to adapt content, pace, and teaching strategies to individual learners. This innovation aligns with global efforts to enhance educational equity and efficiency, particularly in under-resourced settings (UNESCO, 2021).

AI-powered adaptive learning platforms analyze students' learning behaviors and adjust instructional content to meet their needs. For instance, systems like Dream Box and Smart Sparrow use real-time data to modify lesson difficulty, ensuring students remain engaged and challenged (Holmes et al., 2019). Adaptive learning improves comprehension rates and reduces achievement gaps, particularly for students in underperforming groups. AI-driven predictive analytics help educators identify at-risk students early by analyzing patterns in attendance, participation, and academic performance. Tools such as IBM Watson Education provide actionable insights that enable timely interventions, reducing dropout rates and improving overall retention (Chen, Chen & Lin, 2020). AI-powered tutoring systems like Carnegie Learning and Duolingo offer one-on-one assistance by simulating the interaction between a student and a human tutor. These systems provide immediate feedback, fostering self-paced learning and addressing specific learning challenges. Studies show that such systems can improve learning outcomes by up to 30% in mathematics and language acquisition (VanLehn, 2011).

AI-driven personalized learning holds the potential to bridge educational inequities by:

- **Providing Tailored Instruction in Underserved Communities** AI technologies can deliver high-quality educational resources to remote and underprivileged areas, where access to trained educators is limited (Winthrop & Smith, 2019).
- **Accommodating Diverse Learning Styles** By leveraging multimodal learning tools (audio, visual, and kinesthetic), AI platforms cater to students with varying cognitive preferences and abilities, including those with special needs (Holmes, Bialik, & Fadel, (2019).
- **Enhancing Language Learning for Non-Native Speakers** Natural Language Processing (NLP) technologies in AI facilitate the creation of multilingual content and real-time language translation, improving inclusivity in classrooms (Chen et al., 2020).

AI integration in education faces several challenges:

- **High Costs of Developing and maintaining** AI technologies requires significant financial investment, often placing them out of reach for low-income schools and communities (Winthrop & Smith, 2019).
- **Ethical Concerns** AI systems must address issues of data privacy, algorithmic bias, and transparency to ensure ethical use (Luckin et al., 2016).
- **Teacher Training** Effective AI implementation requires educators to understand and embrace the technology. Insufficient training can hinder adoption and limit its benefits (Chen et al., 2020).

The Concept of Personalized Learning

Personalized learning recognizes that each student is unique, with distinct learning preferences, strengths, and areas that require more attention (Rane, Choudhary & Rane, 2023, Singh, 2023). This approach aims to tailor the educational experience to meet individual needs, fostering a deeper understanding and retention of knowledge. Personalized learning represents a student-centric approach to education, acknowledging and accommodating the unique attributes of each learner.

At its core, personalized learning tailors instructional content, pacing, and assessment to the specific needs of individuals, moving away from the traditional one-size-fits-all model. The principles of personalized learning include flexibility, adaptability, and a focus on student agency, fostering a dynamic educational environment. With the help of AI, educators can now harness vast amounts of data to create customized learning journeys for each student, ensuring they progress at their own pace (Akyuz, 2020, Kim & Kim, 2020). Furthermore, in the realm of education, the concept of personalized learning has emerged as a transformative force, challenging the traditional one-size-fits-all approach that has characterized classrooms for decades. Personalized learning is rooted in the understanding that every student possesses unique strengths, weaknesses, and learning styles. As technology advances, particularly with the integration of artificial intelligence (AI), the rise of personalized learning is becoming increasingly pronounced (Bahman, & Siamak, 2020)

The shift towards personalized learning signifies a departure from the rigid structure of standardized education. It embraces the idea that students should have a more tailored and individualized educational experience. This approach recognizes that learners excel when they are given the opportunity to progress at their own pace, delve into topics of personal interest, and receive targeted support where needed conditions are met (Anis, 2023, Khonturaev, 2023, Tapalova & Zhiyenbayeva, 2022). Key to the rise of personalized learning is the utilization of technology, particularly AI, which enables educators to gather and analyze vast amounts of data about each student (Bahman & Farhang, 2024). By leveraging this data, educators can create customized learning paths that cater to the specific needs and preferences of individual students. AI algorithms can assess a student's strengths and weaknesses, track their progress, and adapt instructional strategies accordingly.

Personalized learning is not solely about technology; it is a paradigm shift in pedagogy. It emphasizes the importance of student agency, allowing learners to take an active role in their education. With personalized learning, students become partners in the learning process, making choices about how they acquire and demonstrate knowledge. Furthermore, personalized learning holds the promise of addressing the diverse needs of students. Students with different learning styles, abilities, and backgrounds can benefit from an education that is tailored to their individual requirements. This approach fosters a more inclusive and equitable educational system, where each student is given the opportunity to thrive.

Artificial Intelligence

The term Artificial Intelligence (AI) was first coined by John McCarthy in 1956, two years after the death of Alan Turing, known as the father of AI. He was thinking about how a machine can think and developed a machine, called the Turing machine that demonstrates intelligence like human beings such as learning, logical reasoning and problem-solving etc. (Singh and Jain, 2018). AI predicts new scenarios based on a large number of historical data and this is a sector of unutilized potential (Panigrahi, 2020). The advancement of faster computer processes, the availability of large amounts of big data and progress in computational approaches established the

base for the renaissance of AI that now has been an integral and inseparable part of human life. Anomalously the more it gets integrated into life, the fewer people think of it as Artificial Intelligence (Holmes Bialik & Fadel, 2019).

Artificial intelligence plays a pivotal role in the realm of personalized learning. Advanced algorithms analyze data from various sources, including students' past performance, preferences, and real-time feedback. These insights enable educators to develop highly targeted lesson plans, recommend supplementary materials, and adapt teaching methods to suit the individual needs of each student. AI integration is causing a paradigm shift in education. This article examines how AI creates individualized learning journeys by customizing educational experiences to meet each student's needs. Smart classrooms, virtual tutors, and adaptive learning platforms are mentioned as tools that empower teachers and improve the learning process (Bahman, & Siamak, 2020).

Artificial Intelligence (AI) with its sub-systems such as Machine Learning (ML) and Deep Learning (DL) is also bringing in a new era of personalized, adaptive, and needs-based learning for education, which is altering the field significantly (Bahman & Farhang, 2024). Beyond conventional paradigms, AI in education offers a paradigm shift toward individualized learning experiences. Using machine learning algorithms, adaptive learning platforms assess students' learning styles, strengths, and shortcomings before delivering feedback and content that is specifically suited to them. Artificial intelligence-enabled virtual instructors help students understand difficult subjects at their own speed, creating a more inclusive and productive learning environment. AI is used in smart classrooms to produce dynamic, interactive teachings that appeal to each student's individual interests and skills. As artificial intelligence (AI) becomes more and more integrated into education, it not only improves student performance but also fosters a love of lifelong learning by meeting their varied requirements, ultimately changing the face of education.

Adaptive Learning Systems/ Platforms and Personalized Learning

Adaptive learning systems (also known as adaptive learning environments /platforms) aim at helping learners acquire knowledge and skills in a specific learning domain. Artificial Intelligence (AI) integrated into adaptive learning systems holds transformative potential for education by enabling personalized, data-driven instruction tailored to individual learners' needs. These platforms utilize machine learning algorithms and predictive analytics to continuously assess student performance, learning styles, and engagement levels, dynamically adjusting content and feedback in real time (Joshi, 2023). Unlike traditional teaching methods, adaptive learning systems powered by AI can identify gaps in understanding and offer targeted interventions, thereby enhancing mastery and retention. This individualized approach not only improves academic outcomes but also fosters learner autonomy and motivation, making education more inclusive and effective.

Moreover, AI-driven adaptive platforms promise to revolutionize classroom management and instructional design by reducing the cognitive load on educators.

Teachers can leverage these systems to monitor student progress, identify at-risk learners, and customize lesson plans with greater precision. As Abrams (2025) notes, generative AI tools are increasingly being used to support personalized learning and assessment, allowing educators to focus more on mentorship and emotional support. These platforms also facilitate scalable education solutions, making high-quality, personalized learning accessible to diverse populations across geographies and socioeconomic backgrounds. The goal is to improve individual learning in terms of speed, accuracy, quality, and quantity. These systems customize educational content to meet the unique needs of each student by adjusting the difficulty and type of content based on the learner's progress and understanding (Chahana,2024). Example: Dream Box adapts math lessons to suit the learning pace and style of each student. In today's adaptive learning settings, a variety of adaption approaches are applied.

Adaptive learning systems have been growing in popularity since the early days of e-learning. Their ability to deliver instructions, assistance, and content matched to learners' specific requirements holds a lot of promise for optimizing learning processes. Adaptive systems have grown in sophistication and prevalence as a result of recent technology breakthroughs (Emmanuel,2024). Since adaptive learning is seen as a stimulus to enhance learning and boost student engagement, creating suitable adaptive learning environments helps to tailor education according to the learning objectives and learning needs of students.

The effectiveness of adaptive educational systems relies on the methods used to collect and analyze information about students' learning needs and characteristics. This information is then processed to create an adaptive and intelligent learning environment. As a results to developing accurate student profiles and models based on an assessment of their affective states, degree and kind of knowledge, personality traits, and talents (Shute & Zapata-Rivera, 2017). Data must be used efficiently to create an adaptable learning environment. Educational data mining and learner analytics overlap and can play a significant role in developing such capabilities.

Predictive Analytics and Personalised Learning

Predictive analytics in student success refers to the use of statistical techniques, machine learning algorithms, and data mining to forecast academic outcomes and identify students at risk of underperforming. By analyzing historical and real-time data such as attendance records, grades, engagement metrics, and demographic information educators can uncover patterns that signal potential academic challenges. This proactive approach enables institutions to intervene early, offering tailored support to improve retention and graduation rates (Dagdagui, 2022). The core of predictive analytics lies in its ability to transform raw educational data into actionable insights. Techniques such as regression analysis, decision trees, and support vector machines are commonly employed to build models that predict student performance. For instance, multiple linear regression has been used to correlate high school GPA, admission test scores, and course selection with first-year academic success, yielding predictive accuracy rates upwards of 67% (Dagdagui, 2022). These

models not only forecast outcomes but also help refine admission policies and academic advising strategies.

Moreover, predictive analytics fosters a data-driven culture in education, where decisions are informed by evidence rather than intuition. Institutions leveraging these tools can personalize learning experiences, optimize resource allocation, and enhance student engagement. As Huang et al. (2020) emphasize, the integration of learning analytics and big data in classrooms allows educators to target at-risk students and implement timely interventions based on behavioral analysis. This shift from reactive to proactive educational support marks a transformative step toward improving student success in higher education. It helps to identify students at risk of falling behind or dropping out early. By analyzing student data, AI-powered systems can detect patterns and provide personalized interventions to improve student outcomes (Hinojo-Lucena, Aznar-Díaz, Cáceres-Reche, & Romero Rodríguez, 2019; Zawacki-Richter, Marín, Bond, & Gouverneur, 2019). These systems leverage machine learning algorithms to predict student performance based on factors like attendance, grades, engagement, and demographic information. This allows educators to proactively support struggling students and tailor learning experiences to individual needs.

Intelligent Tutoring Systems (ITS) or Intelligent Computer-Aided Instruction and Personalised Learning

Intelligent Tutoring Systems (ITS), also known as Intelligent Computer-Aided Instruction, are advanced educational technologies that simulate the personalized guidance of a human tutor by leveraging artificial intelligence, cognitive science, and learning analytics. These systems dynamically assess a learner's knowledge, skills, and emotional state through a process called student modeling, allowing them to adapt instructional content and feedback in real time (Graesser, Conley, & Olney, 2012). Unlike traditional computer-aided instruction, which often follows a fixed curriculum, ITS provide individualized learning paths, enabling students to progress at their own pace while receiving targeted support. Research has shown that ITS can significantly enhance learning outcomes, particularly in STEM subjects, by fostering deeper engagement and promoting mastery through interactive problem-solving environments (Ma, Adesope, Nesbit, & Liu, 2014).

The availability of Digital Tutors, which assist students in solving problems and finding the best answers to their inquiries, was a significant element in driving interest in AI-enabled Learning Management Systems (Case, 2020).

Artificial intelligence (AI) is used by intelligent tutoring systems (ITS) to deliver customised, flexible learning. With the goal of assisting every learner in achieving success, these systems evaluate student performance, pinpoint knowledge gaps, and provide tailored training and feedback. These systems analyze student performance, identify knowledge gaps, and deliver customized instruction and feedback to help each learner succeed. They are AI-powered systems that provide personalized tutoring, similar to a human tutor. They offer real-time feedback and

adjust their teaching strategies based on student performance. Example: Carnegie learning provides personalized math tutoring by adapting to the student's learning needs. The following are different forms of intelligent tutoring systems:

- **Enhanced Learning Management Systems (LMS):** These systems can predict student performance, recommend resources, and create personalized learning paths. Example: Blackboard uses AI to analyze student data and enhance the learning experience.
- **Automated Grading and Feedback:** AI tools can grade assignments, quizzes, and exams automatically, providing instant feedback to students. Example: Grade scope uses AI to assist with grading various types of assignments.
- **Content Creation and Curation:** AI tools assist educators in creating and curating educational content such as quizzes, flashcards, and interactive modules. Example: Quizlet's AI features help generate study sets and practice tests tailored to the user's needs.
- **Virtual Teaching Assistants:** AI-powered virtual assistants help manage classroom activities, answer student questions, and provide additional support, often through chatbots or voice-activated systems. Example: Jill Watson, an AI TA developed at Georgia Tech, assists students by answering questions and providing information.
- **Collaborative Learning Tools:** These tools facilitate communication, manage group projects, and provide tools for collaborative learning experiences for teachers and students. Example: Microsoft Teams with AI features helps manage group activities and provides tools for virtual collaboration.
- **Speech-to-Text and Text-to-Speech Tools:** These tools convert spoken language to written text and vice versa, aiding students with disabilities and supporting language learning. Example: Google Speech-to-Text helps transcribe lectures in real-time, making content accessible to more students.
- **Data Analytics and Insights:** AI tools analyze educational data to provide insights into student performance, engagement, and areas needing improvement. Example: Bright Bytes offers data analytics solutions that help schools understand and improve student outcomes.
- **Language Learning Tools:** AI-driven applications designed specifically for language acquisition. They offer personalized lessons, practice exercises, and real-time feedback on pronunciation and grammar. Example: Duolingo uses AI to tailor language lessons to individual learners.
- **Advancing Equity through Artificial Intelligence**
AI-driven personalized learning holds the potential to bridge educational inequities by:

- e. Providing Tailored Instruction in Underserved Communities AI technologies can deliver high-quality educational resources to remote and underprivileged areas, where access to trained educators is limited (Winthrop & Smith, 2019).
- f. Accommodating Diverse Learning Styles By leveraging multimodal learning tools (audio, visual, and kinesthetic), AI platforms cater to students with varying cognitive preferences and abilities, including those with special needs (Holmes et al., 2019).
- g. Enhancing Language Learning for Non-Native Speakers Natural Language Processing (NLP) technologies in AI facilitate the creation of multilingual content and real-time language translation, improving inclusivity in classrooms (Chen et al., 2020).

Educational Equity through Personalized Learning and Artificial Intelligence Integration

Artificial Intelligence (AI) and personalized learning platforms offer a powerful pathway toward educational equity by tailoring instruction to meet the diverse needs of learners. These systems analyze individual learning patterns, preferences, and performance data to deliver customized content and support, ensuring that students regardless of background receive instruction that aligns with their unique strengths and challenges (Ayeeni et al., 2024). This approach moves beyond the traditional one-size-fits-all model, helping to close achievement gaps for marginalized groups, students with disabilities, and those in under-resourced communities. By providing real-time feedback, adaptive assessments, and differentiated learning paths, AI empowers learners to progress at their own pace, fostering both inclusion and academic success. Technological advancements have democratized education by expanding access, personalizing learning experiences, fostering collaboration, enhancing engagement, and improving efficiency

Furthermore, AI-powered personalized learning systems can democratize access to quality education by extending learning opportunities beyond the physical classroom. These platforms support remote and hybrid learning environments, making education more accessible to students in rural or underserved regions (Ghasempour et al., 2025). When designed with equity in mind, AI tools can identify at-risk learners early, offer targeted interventions, and support culturally responsive pedagogy. AI-driven personalized learning holds the potential to bridge educational inequities by:

- h. Providing Tailored Instruction in Underserved Communities, AI technologies can deliver high-quality educational resources to remote and underprivileged areas, where access to trained educators is limited (Winthrop & Smith, 2019).
- i. Accommodating Diverse Learning Styles by leveraging multimodal learning tools (audio, visual, and kinesthetic), AI platforms cater to students with varying cognitive preferences and abilities, including those with special needs (Holmes et al., 2019).
- j. Enhancing Language Learning for Non-Native Speakers, Natural Language Processing (NLP) technologies in AI facilitate the creation of multilingual content and real-time language translation, improving inclusivity in classrooms (Chen et al., 2020).

Conclusion

In the realm of education, the concept of personalized learning has emerged as a transformative force, challenging the traditional one-size-fits-all approach that has characterized classrooms for decades. Personalized learning is rooted in the understanding that every student possesses unique strengths, weaknesses, and learning styles. As technology advances, particularly with the integration of artificial intelligence (AI), the rise of personalized learning is becoming increasingly pronounced. The shift towards personalized learning signifies a departure from the rigid structure of standardized education. It embraces the idea that students should have a more tailored and individualized educational experience. This approach recognizes that learners excel when they are given the opportunity to progress at their own pace, delve into topics of personal interest, and receive targeted support where needed.

Recommendation as the Way forward

- Federal and State ministries of education in Nigeria should work out the modalities for the full adoption of personalized learning empowered by artificial intelligences into the Nigerian educational system since they come with platforms that provide dynamic content and assessments that adjust student's performance and understanding of instructions.
- Policies should be formulated by policy makers for the full implementation of Artificial intelligence adoption in our educational system and the provision of the n
- The government at all levels should be proactive with vigorous training programmes for teachers especially at the teacher training institutions as well as in-service training in order to fit into this paradigm shift in pedagogy.
- Students should be aware that they are partners in the learning process making choices about how they acquire and demonstrate knowledge, especially those with different learning styles, abilities, and backgrounds so as to benefit from an education that is tailored to their individual requirements.

References

- Abrams, Z. (2025). Classrooms are adapting to the use of artificial intelligence. *Monitor on Psychology*, 56(1), 115-110
- Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). AI in education: A review of personalized learning and educational technology. *GSC Advanced Research and Reviews*, 18(2), 261–271
- Bahman Zohuri and Farhang Mossavar-Rahmani,(2024).The Symbiotic Evolution: Artificial Intelligence (AI) Enhancing Human Intelligence (HI), An Innovative Technology Collaboration and Synergy. *Journal of Material Science & Applied Engineering*,3(1)1-5
- Bahman, Z., Siamak, Z. (2020) Artificial Intelligence Driven by Machine Learning and Deep Learning. 1st Edition, Nova: Science Pub Inc.
- Chahana, D.(2024). Revolutionizing Education through AI-Powered Inclusive Learning Systems. *Journal of the Association for the Advancement of Artificial Intelligence* 2 (3) 14-20
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *Journal of Educational Technology Development and Exchange*, 13(1), 45–62
- Dagdagui, R. T. (2022). Predicting students' academic performance using regression analysis. *American Journal of Educational Research*, 10(11), 640–646
- Emmanuel Dumbuya (2024). Personalized learning through artificial intelligence: Revolutionizing education. *International Journal of Science and Research*, 13(02), 2818-2820

- Ghasempour, E., Ghasempour, E., & Raman, P. (2025). AI-powered Personalized Learning Systems: A Review of Equity, Access, and Ethical Implications.
- Graesser, A. C., Conley, M. W., & Olney, A. (2012). Intelligent tutoring systems. In K. R. Harris, S. Graham, T. Urdan, A. G. Bus, S. Major, & H. L. Swanson (Eds.), *APA educational psychology handbook*, Vol. 3 (3) 451–473. *American Psychological Association*
- Hinojo-Lucena, F. J., Aznar-Díaz, I., Cáceres-Reche, M. P., & RomeroRodríguez, J. M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. *Education Sciences*, 9(1), 51.
- Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Center for Curriculum Redesign.
- Huang, A. Y. Q., Lu, O. H. T., Huang, J. C. H., Yin, C. J., & Yang, S. J. H. (2020). Predicting students' academic performance by using educational big data and learning analytics: Evaluation of classification methods and learning logs. *Interactive Learning Environments*, 28(2), 206–230
- Joshi, M. A. (2023). Adaptive learning through artificial intelligence. *International Journal of Innovative Research in Science, Engineering and Technology*, 4(4), 001–002.
- Kim, J. N. & Kim, K. M. (2022). Teacher's Perceptions of Using an Artificial Intelligence-Based Educational Tool for Scientific Writing. *Digital Learning Innovations*, 7(1), 23–27
- Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence Unleashed: An argument for AI in Education*. Pearson Education.
- Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q. (2014). Intelligent tutoring systems and learning outcomes: A meta-analysis. *Journal of Educational Psychology*, 106(4), 901–918.
- Muh. P. P., Rigel, S. & Hans, L.(2023). Revolutionizing education: Harnessing the power of artificial intelligence for personalized learning. *Journal of Education, Language Teaching and Science Volume 5*(2) 112-118
- Panigrahi, C. M. A. (2020). Use of Artificial Intelligence in education. *Journal of management. accountant*, 55, 64-67
- Rane, N. L., Choudhary, S. P., Tawde, A., & Rane, J. (2023). ChatGPT is not capable of serving as an author: ethical concerns and challenges of large language models in education. *International Research Journal of Modernization in Engineering Technology and Science*, 5(10), 851-874.<https://www.doi.org/10.56726/IRJMETS45212>
- Singh Nandini Chatterjee and Jain Raunak. (2018). Personalizing 'Learning' - Can AI Promise Customised Education for 'Humanity'
- UNESCO. (2021). *Re-imagining our futures together: A new social contract for education*. United Nations Educational, Scientific, and Cultural Organization.
- VanLehn, K. (2011). The Relative Effectiveness of Human Tutoring, Intelligent Tutoring Systems, and Other Tutoring Systems. *Educational Psychologist*, 46(4), 197–221.
- Wang, Q., Cui, T., & Wang, W. (2020). Artificial Intelligence in Education: Advances and Future Trends. *Journal of Educational Technology Development and Exchange*, 13(1), 3- 17.<https://doi.org/10.1878 5/jetde.1301.02>
- Winthrop, R., & Smith, M. S. (2019). *Leveraging Technology to Improve Learning in Low-Income Countries*. Brookings Institution Report.
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education—where are the educators?. *International Journal of Educational Technology in Higher Education*, 16(1), 1-27