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THE CONTRIBUTION OF ARTIFICIAL INTELLIGENCE TO IMPROVING TEACHING PRACTICES IN MOROCCO: CHALLENGES AND PROSPECTS

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Abstract

This paper investigates the remarkable possibility of AI in educational practices. It introduces new applications of AI in education, describes the technological applications of AI in educational technology, and discusses ethical and technical issues related to its inclusion in education. Indeed, through this study we will discover the strength of artificial intelligence in the field of education, including the personalization of learning, the choice of educational resources, the increase in learner motivation and the development of continuing teacher training. But all this without forgetting to talk about the challenges of integrating this technology and the disadvantages of its use.

Keywords: AI, education, teaching, school system.

1. Introduction

AI is the subfield of computer science dedicated to building systems that can do things that would require intelligence if they were done by humans (McCarthy, 2007). There is undoubtedly no more significant revolution in the world than AI. Technology nowaday is so powerful that it is present in every field of the contemporary life, from health (Gruetzemacher & Whittlestone, 2022) to industry (Javaid et al., 2022),scientific research (Khalifa & Albadawy, 2024),, and, of course, education (N. Nguyen, 2023), without mentioning the role that mining technologies in general and artificial intelligence in particular are playing during coronavirus time not to break continuiity of school (Boumaaize et al., 2021). AI undoubtedly has the potential to affect all aspects of life, either directly or indirectly, and can impact the education field more than ever, as AI can act as a significant aid tool in revolutionizing teaching-learning processes (Luckin et al., 2016). Thanks to this new technology, the possibility to establish a more personal, inclusive, and engaging setting for learning, which can adapt to the particular needs of learners and enhance their learning results. Nevertheless, the application of AI cannot be buried under the carpet, and the AI should be applied in an ethical, inclusive, and human-centric manner (Holmes et al., 2019b).

The Moroccan education system has undergone successive reforms to enhance and modernise it and bring it to the level of the elite, starting from the National Education Charter (2002) to the emergency plan 2009- 2012 to the strategic vision 2015-2030. Work is now in progress on the 2022-2026 roadmap under framework law 51-17 (2009). When we consider these new reform strategies carefully, we find one very popular trend: the embedding of technology in the educational system. Moreover, of course, let us not forget the artificial intelligence piece. Then, how will AI revolutionize teaching methods in Morocco today?

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This paper will systematically analyse the reports, effects, and challenges of AI in teachning practices.

2. Methodology

This article adopts a theoretical and conceptual approach to analyze the contribution of artificial intelligence in education. To this end, our literature search consisted of three phases:
Thematic analysis: organization of references around four main themes: the application of AI in education, pedagogical impacts, challenges and limitations of AI, and finally, perspectives and recommendations for the use of AI.
Critical comparison: confrontation between theoretical contributions, empirical results, and Moroccan educational policies. Integrative synthesis: development of a framework for reflection linking the contributions, limitations, and perspectives of AI in education.

3. AI and Education: Applications of AI in education

Education is a major institution in any country; it is through education that the government can plan projects and programs for the development of society. Next, we will examine the various use cases of AI in education.

3.1 Adaptive and personalized learning

AI enables learners to learn at their own pace. Brusilovsky and Peylo (Brusilovsky & Peylo, 2024) specifically consider web-based educational systems based on artificial intelligence and adaptation, or AIWBES (Adaptive and Intelligent Web-based Educational Systems). Such systems differ from typical content delivery solutions online in that they can model each learner's knowledge, goals, and preferences, adapting to their needs. Intelligent features are incorporated to mimic specific pedagogical interventions made by a teacher, such as error diagnosis or personalised support.

The authors outline five categories of technology utilized in these systems that emerged from the alliance between adaptive hypermedia and intelligent tutoring systems:

- ✓ Personalized presentation and navigation providing the possibility to navigate through the content of the publication;
- ✓ Adaptive information filtering to suggest the appropriate resources, dependent on the learner;
- ✓ Astute classroom observation for teachers to monitor and track students;
- ✓ Intelligent cooperative learning, promoting group building and peer interactions;
- ✓ Tutoring ones, on a cognitive model base, like sequencing learning activities or learners' solutions analysis.

This approach is a departure from early AI systems in education, which focused on specific support (e.g., problem-solving analysis) and towards a fuller, more integrated journey for the learner, which is very well suited for online self-learning environments. AIWBES show, therefore, high potential for enhancing teaching practices and the effectiveness of e-learning for widening access to educational resources.

3.2 Objective evaluation and follow-up of improvement

Consideration is a vital component of the teaching and learning activity because it enables learners to confirm their abilities and knowledge. Also, teachers can focus on learning gaps through test results. In this sense, Romero and Ventura (Romero & Ventura, 2024) provide a broad image of the development and future of two complementary domains, like Educational Data Mining (EDM) and Learning Analytics (LA), in their recent state-of-the-art. Both of these approaches have a similar objective: taking advantage of the big data generated during learning activities to gain insight into and improve educational processes. 3:- Summary The two papers are aiming to solve the same

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problem, and we stress that the authors differ significantly in objectives and target community.
EDM is mainly dedicated to the creation and utilization of sophisticated algorithmic and statistical methods that could uncover latent structures in educational data. It will focus on strong exploration methods to predict learner behavior, identify the risk of drop-out, and personalize learning pathways.
Learning Analytics, in contrast, has a more practical implementation-oriented emphasis on the needs of practitioners (teachers and administrators). It aims to make data actionable in order to drive real-time decision-making and to enable personalized learning.
The authors also investigate the different tools and methods employed, including both supervised classification techniques (such as decision trees and neural networks) and unsupervised techniques (such as text mining and social network analysis), as well as supervised and unsupervised data visualization methods. They highlight the increasing relevance of hybrid methods, i.e., those using multiple techniques to understand complex trajectories of learning better.
Romero and Ventura believe that the combination of EDM and LA is necessary to address the current challenges in digital education and the convergence of scientific principles and practical applications to enhance the effectiveness of educational systems.

3.3 Virtual assistants and educational chatbots

Anyone who has ever taken a class knows that feedback is vital to learning and that instant feedback is key. Luckily for us all, this is the convenience of chat-bots (ChatGPT, for example) in an article called "Bots as language learning tools. 2016b) “Reported here Learning with robots: teachers’ views Robots/a l peers and mentors (“bots” training tool Computer Assisted Language Learning”, Fryer, Luke, and Carpenter (Luke, 2006)investigate the role of conversational robots (“bots”) as a language pool for help in language learning. Their investigation is premised on the concept that such computer characters may supply an interactive yet non-threatening environment for language application, specifically in classic language learning scenarios.
Chatbots, Fryer and Carpenter add, offer a safe space for linguistic play, especially among shyer or less confident learners. Their research demonstrates that such bots can support autonomy and motivation, but their effectiveness also depends mainly on their capacity to generate realistic user-adapted conversations.

3.4 Development of interactive Class-in hints.

Text underneath the lesson is a non-interactive, introductory text about the topic. Students have the flexibility to complete the assignments and can choose to do them in class or at home.
Connolly et al. (Connolly et al., 2012) reviewed literature to evaluate the positive effects of video games and serious games in learning and skill acquisition, as well as user engagement, for individuals from 14 years upwards. Their study was grounded on an examination of 129 empirical studies across various games and educational settings.

Games, whether for fun or education, have a range of effects, according to the study:

- ✓ Learning content: Serious games and educational games have a positive impact on knowledge acquisition, more precisely in the health, social sciences, and hard sciences areas.
- ✓ Perceptual and Cognitive Abilities: Action games are beneficial and enhance players’ concentration and visual-spatial capacities.
- ✓ Motor skills: Training simulators in practical skill training in technical or medical education are beneficial.
- ✓ Motivational and emotional effects: Games are motivational to learners through the active involvement they play in galvanizing learning.
- ✓ Behavioral change and social competences: An extraordinary, yes, but empirical evidence is also to the same extent, such effects of games include, besides, changes in attitudes towards or

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behavior, as well as the development of cooperation and communication skills.

4 Effects of AI on educational methods

4.1 Enhancing motivation and engagement of learners

Howard-Jones and Demetriou (Howard-Jones & Demetriou, 2008) also examine how the introduction of uncertainty in gaming environments could promote learners' emotional and motivational engagement in digital educational environments. The authors conduct three empirical studies, which show that the introduction of random or uncertain features (e.g., a dice or a coin) in educational games can trigger attention, curiosity, and the fun of learning, even though these uncertain features can have a limited impact on the educational material.

The authors chose three distinct age groups (10–11 years, 13–14 years, and adults) to cover different stages of cognitive and socio-emotional development.

Study 1 (10–11-year-olds) reveals that a preference for uncertain outcomes increases when the potential reward stems from a math quiz, as opposed to a social task, evidencing a general attraction to moderate risk that boosts motivation.

Study 2 (13–14-year-old) identifies that peer talk intertwines learning and play, and does not dismiss the unfairness of chance. Ambiguity is seen as a provoking factor of play; it encourages staying power and joint effort.

Study 3 (adults) also registers a significant growth in EDA during learning sessions characterized by playful confidence, with the implication of increased emotional arousal, conducive to learning and memorization.

Such findings point to the potential benefits of intelligent educational systems that harness the neural reward correcting signal that is likely associated with uncertainty in order to optimize learners' cognitive and emotional engagement at the moment of learning.

4.2 Differentiated instruction

Differentiation is key to successful teaching with a mixed-ability group of students. In a 2021 article, Geneviève Bergeron et al. (Przesmycki, 2008) explore how teachers in Quebec high schools understand and apply differentiation (DI) in the specific context of inclusive education. Though the ministerial policies recommend a PD to develop individual teachers' capacities to respond to student diversity, teachers frequently do not feel well-equipped or supported to undertake such work. Findings: A qualitative research study involving a dozen teachers suggests that PD primarily responds to identified students with special needs rather than being a proactive measure to adapt educational practices for all students.

AI can be a critical tool to help teachers during the PDP implementation, including solidarity and grouping. For instance, AI systems could analyze data about student learning to determine what a student needs and recommend the most effective teaching methods for instructional design. AI can also inform them to create customized learning paths, a more proactive model for PD, which can benefit all students, and not only those flagged as special needs.

4.3 Task optimization

In a 2013 study , Drigas and Ioannidou (Drigas & Ioannidou, 2013) investigated the contribution of information and communication technology (ICT) to special education, analyzing the diagnostic and intervention tools designed from 2001 to 2010. The authors comment that ICT has critical potential for enhancing access to learning and for supporting students with SEN in attaining a greater level of autonomy.

The inclusion of AI in educational ICT can enforce diagnostic and intervention potential in special education. For instance, AI programs can examine student data sets to spot struggles early and suggest targeted interventions. Furthermore, AI can advance the development of adaptive learning environments, which adjust instantly to the individual student's requirements to enhance their

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engagement and academic performance

5 Challenges and Bottlenecks for the AI integration

5.1 Ethical issues

Holmes et al (Holmes et al., 2019b) warned that the implementation of artificial intelligence in education is not possible without a thorough consideration of ethics. While AI has the potential to develop personalized learning, automated assessment, and intelligent tutoring, it also poses significant risks and challenges that need to be addressed.

The study's findings:

✓ Algorithmic bias: AI systems are trained on human data, and so they can replicate or magnify social, sexual, or racial discrimination.

✓ Transparency and accountability: the decisions made by AI (e.g., assessment, providing guidance) can be non-transparent, and therefore hard for the teacher and students to comprehend and challenge.

✓ Privacy and surveillance: the mass datafication of the child datafies childhood, with privacy concerns about personal data and the extent to which personal data is used for commercial purposes.

✓ Access to opportunity: AI-enabled educational technologies may create disparities in access, particularly in poorer communities or regions/countries.

✓ Dehumanization of learning: An over-automation of learning experience could take away human interaction, which is crucial for students to learn effectively and to develop socio-emotionally.

5.2 Technical limitations

Moreover, technology develops — it will always keep developing — there are always limits, limits that can never be surpassed and limits that should not. According to Mutlu Cukurova and Rose Luckin (Cukurova & Luckin, 2018), AI in education has technical limitations, such as:

Quick development of new technologies: The new educational technologies studied by the authors, including AI, are rapidly evolving, making it challenging to adapt traditional evaluation instruments. This fluid quality makes it hard to determine their lasting influence.

Complexity of man-machine interactions: AI in education should be developed with a detailed consideration of the relationship between users and systems. The authors point out that complex features of the new educational technologies imply they can only be usefully understood by studying their interaction.

Variance of new technologies: There is significant variation between new technologies, and design and use have an important influence on the impact on education outcomes. This means that the effectiveness of AI in education is greatly influenced by its design and customization in the context.

The need for a clear theory of change: A well-developed theory of change is required in order to assess the transformative potential of new technologies. This allows the expected results and suppositions underpinning the intervention effort to be fleshed out and objectively examined.

These points suggest that, while AI holds great promise for education, it is technically challenging to develop and evaluate AI for education.

5.3 Teacher training

Ertmer and Ottenbreit [17](Ertmer & Ottenbreit-Leftwich, 2010) analyze the requirements for meaningful infusion of educational technologies (AI has now become one) in the education of educators. Intervention: A key factor in enabling teachers to integrate technology effectively is the implementation of interventions by teachers to address phenomena in school affairs, specifically related to three key issues in the education environment: knowledge, pedagogical beliefs, and school culture.

The integration of technological tools into teaching practices is a limiting and inhibiting factor that

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the authors identified:

· Integration is frequently limited to either technical or administrative applications (e.g., PowerPoint, information retrieval).
· Insufficiently concrete examples from teaching where ICT supports student-centered working.
· Cultural resistance: young teachers are affected by the older ways of working of their colleagues, even after the training devoted to ICT.

6 Application of Artificial Intelligence in teaching in Morocco

Artificial intelligence (AI) is increasingly shaping Morocco's teaching landscape, offering opportunities to modernize teaching practices and enhance student learning outcomes. Predictive models have recently been applied to detect at-risk students, reaching an accuracy of up to 88%, thus supporting early intervention and personalized learning pathways. Adaptive learning platforms and intelligent tutoring systems are also emerging, enabling content personalization and continuous monitoring of student progress . Moreover, AI is being deployed in educational administration to automate repetitive tasks such as grading multiple-choice exams, streamlining enrollment processes, and providing chatbot-based academic advising (*L'Impact de l'Intelligence Artificielle sur l'Enseignement au Maroc*, 2024).

At the policy level, Morocco has invested in AI teaching by creating the National School of Artificial Intelligence and Data Science in Taroudant, and by integrating AI-related modules into several university programs (Habibi & Elmassouab, 2024). Specific initiatives, such as the Majorit.ma platform for medical students, illustrate how AI can assist in exam preparation and professional training . However, the adoption of AI faces structural challenges, including uneven digital infrastructure between urban and rural areas, insufficient teacher training, and ethical concerns regarding data protection and algorithmic transparency (Habibi & Elmassouab, 2024).

Overall, AI offers Morocco a pathway to more inclusive, adaptive, and effective teaching, provided that technological innovation is coupled with robust governance, ethical safeguards, and capacity-building initiatives.

7 Prospects and recommendations

Domain	Recommendations	Data / Indicators	References
Pedagogical	Promote the use of AI to strengthen active and differentiated pedagogies (e.g., personalized learning, intelligent tutoring).	59% of studies on AI in education report improved academic performance with adaptive learning.	(Ghazal et al., 2024)
Pedagogical	Train teachers to integrate AI as a pedagogical tool rather than a mere substitution technology.	72% of teachers report lacking training to integrate AI into their practices.	(Alenezi, 2023)
Pedagogical	Use AI to support learners' autonomy in adaptive and interactive environments.	Intelligent tutoring systems improve engagement and self-regulation by 30–40%.	(St-Hilaire et al., 2022)
Pedagogical	Encourage co-design of AI-based content with teachers to ensure disciplinary relevance.	Pilot studies show co- design increases perceived relevance by 65% among teachers.	(Mollic & Mollick 2024) ,

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Training Competences	Integrate modules on educational AI into initial and continuous teacher training.	Less than 20% of teacher education programs included AI in 2022.	(Zawacki-Richter et al., 2019)
Training Competences	Develop critical digital literacy for teachers and students, including a basic understanding of algorithms.	UNESCO (2021) stresses ethical and critical training, considered a priority in 80% of surveyed countries.	(UNESCO, 2021)
Technical	Adopt interoperable, secure, and scalable AI solutions compatible with existing systems.	43% of institutions report integration issues between AI tools and their LMS.	(Holmes et al., 2019a)
Technical	Prioritize open-source and explainable technologies where possible for transparency reasons.	Open-source solutions reduce costs by an average of 30% in educational pilot projects.	(UNESCO, 2021)
Technical	Provide sufficient technical infrastructure in schools (internet connection, equipment, support).	45% of secondary schools in Morocco lack high-speed internet.	(Ministère de l'Éducation Nationale (Maroc), 2023)
Ethics & Inclusion	Ensure student privacy protection: minimal data collection, secure storage, informed consent.	67% of teachers express concerns about student data protection.	(UNESCO, 2021)
Ethics & Inclusion	Develop equitable and inclusive AI, avoiding gender, cultural, or cognitive biases.	40% of tested AI systems show linguistic or cultural biases.	(Zawacki-Richter et al., 2019)
Ethics & Inclusion	Involve ethics and governance committees in AI implementation (teachers, parents, researchers).	55% of countries studied by OECD recommend shared governance.	(OECD, 2022)
Ethics & Inclusion	Establish clear appeal procedures in cases of errors or problematic decisions made by AI systems (e.g., automated grading).	Studies show 25% of automated assessment systems display interpretation errors.	(T. T. Nguyen, 2025)

8 Limitations and Future Work

This review is primarily narrative in nature, which, while useful for synthesizing key perspectives, does not provide the empirical validation necessary to confirm the claims. Future research should therefore prioritize systematic empirical investigations through experimental, longitudinal, and mixed-methods designs to test the assumptions highlighted here and to provide stronger evidence based foundations for the integration of IA in educational contexts.

9 Conclusion

Artificial intelligence technology is completely changing the way that we teach and learn. It has enabled us to personalize learning paths, support students with intelligent tutoring, facilitate assessment, and help teachers in their daily teaching. These advances are key to a more personalized, more agile, and equitable education.

However, these opportunities also give rise to numerous challenges. How can we be confident that AI will protect students' privacy? How can algorithmic bias be stopped? Moreover, most importantly, how do we ensure that technology serves the people and not replaces them? It is thus

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crucial to engage teachers, students, parents, and researchers in the choices of technological tools to use, and train educational stakeholders to use them mindfully and ethically.

AI is not a miracle solution. It is a lever of power, provided it is used to serve transparent educational values: logic, respect, mediation, and the progress of the potentialities of each student. By placing people at the center of that transformation, AI can become a responsible ally for a more equitable, efficient, and humane school.

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