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Teachers' training in the age of AI: Moral, social and educational dimensions in using artificial intelligence in training in the Moroccan context

La formation des enseignants à l'ère de l'IA : dimensions morales, sociales et pédagogiques de l'utilisation de l'intelligence artificielle dans la formation dans le contexte marocain

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Abstract:

Digital transformation, accelerated by COVID-19 and AI, is reshaping education in Morocco. As AI increasingly influences teaching and learning, it offers real opportunities for personalized training but also raises fundamental questions about how human learning is changing.

Using a qualitative documentary approach, this article reviews Moroccan policy documents and academic literature on AI in education. It fills a gap in research that while AI-in-education studies are advanced in Western and Asian contexts, the ethical, social, and pedagogical implications specific to Morocco and North Africa remain understudied. The core question of this paper is how to integrate AI into Moroccan teacher training while preserving ethical standards, effectiveness, equity, and educational quality.

Nonetheless, the central concern is protecting essential human qualities creativity, ethical reasoning, and critical thinking as AI reshapes evaluation, equity, and learner autonomy. The issue goes beyond fears of job displacement to defining clear ethical limits for AI in educational decision-making.

The review finds that although Morocco's digital infrastructure is well positioned, the ethical and pedagogical dimensions of AI in teacher training are still underdeveloped in policy. A coordinated, multi-stakeholder framework balancing ethical oversight, equitable access, and pedagogical support is needed to align AI innovation with educational quality.

Keywords: Teacher training, Artificial intelligence, Digital technologies, Education.
Classification JEL: A23, O33, I23, I26
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Introduction

After the COVID-19 pandemic, the world has undergone a significant transformation across several fields (technological, social, educational, and organisational). People across the globe have increasingly integrated digital technologies into their daily activities, from physical learning to online learning and remote work, generating new opportunities in a rapidly evolving world. This digital wave has influenced educational systems worldwide, and the emergence of AI and the diversification of its tools have made the integration of digital technologies, including AI, into learning and teaching processes increasingly necessary. In recent years, the Moroccan government has implemented several projects related to digital transformation in education, such as the "Development of Digital Education in Schools" project, which aims to equip schools with digital tools and train teachers in their use, and the "Distance Learning Applications" launched during the COVID-19 pandemic, which helped ensure educational continuity (Moroccan Ministry of National Education, 2020). These early adaptations were not without difficulty and struggling, comparable experiences elsewhere showed that the rapid shift to online teaching during school closures significantly affected the competencies and confidence of early-career teachers in particular (König, Jäger-Biela, & Glutsch, 2020), a concern that also applies to the Moroccan context and reinforces the need for structured teacher training in digital and AI tools.

These initiatives form part of a broader set of national digital strategies, from Maroc Numeric 2013, Digital Morocco 2030 and the Digital Morocco for Sustainable Development (D4SD) programme launched in 2025, which together illustrate the government's commitment to positioning Morocco as a digital hub and to improving public-service transparency and data security. This macro-economic and infrastructural context, while relevant, is not the primary object of this article; it is presented in greater detail in Section 2.2, which situates it more precisely in relation to the digitalisation of education specifically.

Digital technologies and artificial intelligence have the potential to address some of the most pressing challenges in education today, to renew teaching and learning practices, and ultimately to accelerate progress toward Sustainable Development Goal 4 (Miao, Holmes, Huang, & Zhang, 2021). However, these rapid technological developments inevitably raise multiple risks and challenges that have so far outpaced policy debates and regulatory frameworks (Miao et al., 2021). In the Moroccan context specifically, AI-based technologies have begun to reshape the educational system, the functions of teachers, and the overall dynamics of the education sector, teachers now design class content with the help of AI tools and increasingly transition from face-to-face instruction to online teaching and tutoring. From being the primary source of information, teachers have become facilitators of access to information, which is now available everywhere; AI has thereby simplified certain processes of learning and teaching.

Yet, the existing literature on AI in teacher training has largely focused on Western, Asian, and international contexts (e.g., Davin et al., 2025; Lucas, Bem-Haja, Zhang, Llorente-Cejudo, & Palacios-Rodríguez, 2025), with comparatively little attention paid to the specific moral, social and educational configurations of North African and Moroccan contexts, beyond a handful of exploratory contributions such as that of Nejjari and Hammou (2024). This gap is significant given Morocco's distinctive linguistic plurality, regional disparities, and ongoing structural reforms of teacher training, which are likely to shape AI adoption in ways that differ from contexts more frequently studied in the literature.

Therefore, the central issue this article addresses is how to preserve the essential human cornerstones of education, namely creativity, ethical reasoning and critical thinking, while exploiting AI's potential to improve training effectiveness. As AI systems increasingly influence learning processes, evaluation methods, educational equity, and learners' autonomy, the challenge extends beyond concerns about job displacement for educators to the definition

of ethical boundaries for AI-based decision-making in training environments. Accordingly, and using a qualitative documentary approach based on a review of official documents and peer-reviewed literature, this research addresses the following central question: to what extent can artificial intelligence be integrated into teacher training programmes in Morocco in a way that preserves ethical standards, effectiveness, educational quality, social equity and moral responsibility toward learners? This central question is examined through three complementary sub-questions relating, respectively, to the educational dimension (effectiveness and quality, Section 3), the moral dimension (ethics and responsibility, Section 4) and the social dimension (equity and inclusion, Section 5) of AI integration.

The remainder of this article is organised as follows. Section 1 presents the conceptual and theoretical framework mobilised in the study, section 2 provides a state of the art of the digitalisation of education and teacher training in Morocco, section 3 details the methodological protocol of the literature review and examines the educational dimension of AI integration, sections 4 and 5 respectively address the moral and social dimensions and last but not least section 6 proposes an integration framework for responsible implementation, before the conclusion synthesises the findings, discusses the limits of the study, and outlines avenues for future research.

1. Conceptual and Theoretical Framework

1.1 Artificial Intelligence

The term "artificial intelligence" was first used at a 1956 workshop held at Dartmouth College to describe the science and engineering of making intelligent machines, especially intelligent computer programmes (McCarthy, Minsky, Rochester, & Shannon, 2006). Over the following decades, AI developed in fits and starts, with periods of rapid progress interspersed with so-called "AI winters" (Russell & Norvig, 2016).

Moreover, artificial intelligence refers to the ability of a digital machine to perform tasks commonly carried out by intelligent beings; the associated technologies are divided into several branches, such as computer vision, speech processing, machine learning, big data and natural language processing (Chi et al., 2022, as cited in Leroux, 2023). In other words, artificial intelligence designates computer systems capable of performing complex tasks normally carried out through human reasoning, decision-making or creation.

However, the National Aeronautics and Space Administration (NASA, 2024) notes that there is no single, simple definition of artificial intelligence, since AI tools are capable of a wide range of tasks and outputs. Artificial intelligence and related technologies have been employed to simulate human decision-making processes in order to improve people's lives (Chao, Hsu, Liu, & Cheng, 2021). AI uses data and algorithms to train computers to make classifications, generate predictions, or uncover similarities or trends across large datasets.

Nonetheless, for the purposes of this article, and in line with Chi et al. (2022, as cited in Leroux, 2023), artificial intelligence is understood as the set of digital technologies, including machine learning and natural language processing, that enable a system to perform tasks ordinarily requiring human reasoning, and that are increasingly mobilised in teacher training environments.

1.2 Artificial Intelligence in Education

Artificial intelligence has the potential to address some of the most pressing challenges in education today, to renew teaching and learning practices, and to accelerate progress towards SDG 4; Nonetheless, these rapid technological developments inevitably raise multiple risks and challenges that have so far outpaced policy debates and regulatory frameworks (UNESCO, 2024).

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Artificial intelligence is rapidly transforming the way societies live, work and learn; to help education systems keep pace, UNESCO has launched two AI competency frameworks, one for students and one for teachers (UNESCO, 2024). More broadly, research on AI in education has evolved from early computer-assisted instruction to increasingly adaptive, data-driven systems (Roll & Wylie, 2016), a trajectory that underlies the intelligent tutoring systems discussed in Section 3. When it comes to the distinction between AI and other digital technologies in education, AI has the potential to profoundly reshape international and national education systems, societies and economies.

Moreover, unlike conventional information and communication technologies (ICT), AI poses unique ethical and social challenges, such as issues of fairness, transparency, privacy and accountability. Additionally, AI's unique ability to imitate human behaviour directly affects human agency. These challenges require dedicated competencies that go beyond the scope of traditional digital literacy.

1.3 Teacher Training and Continuous Professional Development (CPD) in the Age of AI

Professional development has been described as the set of activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher, according to OECD study covering 23 countries (OECD, 2009). The quality of any education system depends substantially on the quality of its teachers (Goodwin et al., 2014; Lee, 2018; Tucker, 2019). Guskey (2002) notes that teacher professional development programmes seek to change teachers' classroom practices, attitudes and beliefs, and thereby to influence students' learning outcomes. The need for appropriate teacher preparation and professional development has driven teacher education reforms in various countries with regard to policy, recruitment practices, and programme design aimed at producing quality teachers (Mgaiwa & Milinga, 2024).

Knapp (2003) similarly distinguishes professional learning from professional development, describing professional learning as linked to changes in the thinking, knowledge, skills, and approaches to instruction that form practicing teachers' or administrators' repertoire (Knapp, 2003, pp. 112-113). Moreover, effective professional development is characterised by features such as content focus, active learning, collaboration, the use of models of effective practice, coaching and feedback, and sustained duration (Darling-Hammond, Hyler, & Gardner, 2017); these features provide useful benchmarks against which AI-based CPD initiatives can subsequently be evaluated.

In today's educational landscape, marked by rapid technological change and the emergence of AI, continuous professional development is no longer optional but a necessity for teachers and education staff wishing to sharpen their practice and develop their careers (Teacher Active, 2025). However, the role of teachers and educators today goes far beyond delivering the curriculum: educators act as mentors, guides, facilitators, and lifelong learners, and ongoing CPD helps them maintain a high level of competency and stay current with best practices. Specifically with regard to AI, CPD must go beyond generic digital-skills training to address AI-specific competencies, namely the capacity to evaluate AI-generated content critically, to understand the ethical and data-related implications of AI tools, and to adapt pedagogical practice to hybrid human-AI teaching environments. This recentring of CPD on AI-specific needs, rather than on digital literacy in general, is developed further in Sections 3 to 5.

1.4 Digital Pedagogy and Competency Frameworks

When it comes to digital pedagogy and competency frameworks, the UNESCO ICT Competency Standards for Teachers (2011) represent an early attempt to identify pedagogical digital competence, articulating competence across six areas (understanding ICT in education, curriculum and assessment, pedagogy, ICT, organisation and administration, and teacher

professional learning) and three levels of competency: technology literacy, knowledge deepening, and knowledge creation.

The European Framework for the Digital Competence of Educators (DigCompEdu) is a scientifically grounded framework describing what it means for educators to be digitally competent, providing a general reference frame to support the development of educator-specific digital competences across all levels of education, from early childhood to higher and adult education (European Commission, Joint Research Centre, 2017).

1.5 Toward an Integrative Conceptual Model

Literally, the concepts mobilised above, namely artificial intelligence, continuous professional development, and digital competency frameworks, are not merely juxtaposed in this article but are organised around an integrative conceptual model that links the three dimensions announced in the title: the educational dimension (effectiveness and quality of AI-based training, examined in Section 3), the moral dimension (ethics and responsibility, examined in Section 4), and the social dimension (equity and inclusion, examined in Section 5).

This model draws on two complementary theoretical anchors. First, the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2009) provides a lens for understanding how AI reconfigures the relationship between technological, pedagogical and content knowledge in teacher training, and thus underpins the educational dimension developed in Section 3. Second, the AI4People ethical framework (Floridi et al., 2018), organised around the principles of beneficence, non-maleficence, autonomy, justice and explicability, underpins the moral dimension developed in Section 4, while also informing the equity concerns addressed in the social dimension in Section 5.

Read together, these two frameworks situate AI integration in teacher training not as a purely technical process but as a socio-technical transformation that must be evaluated simultaneously against pedagogical, ethical and social criteria, an articulation that the remainder of this article examines through the Moroccan case, and that is revisited explicitly in the synthesis proposed in Section 5.4 and in the theoretical anchoring of the integration framework in Section 6.4.

2. State of the Art: Digitalisation of Education and Teacher Training in Morocco

2.1 Current State of Teacher Training in Morocco

In Morocco, teachers undergo various sets of training before actually becoming teachers. Some of this training occurs in governmental institutions such as the Regional Centres for Education and Training Professions (CRMEF), whereas others options for partnership programmes such as the English Teaching Internship Initiative (ETII), an educational programme that aims to provide potential teachers with practical teaching experience (Addichane & Tamimi, 2023).

The creation of the Regional Centres for Education and Training Professions (CRMEF) was an important initiative in the field of teacher training. They constitute the primary government institutions for teacher training in Morocco, offering pre-service (for new teachers) and in-service (for current teachers) programmes, and they focus on equipping teachers with the necessary skills and knowledge, including practical experience and research. The establishment of regional CRMEF centres has made training more accessible and stable, especially for women, by allowing them to train in their own regions rather than relocating to other parts of the country.

Comparative and Moroccan-focused studies confirm the centrality of practical training components in teacher preparation. Arellano Vaca (2015), examining the Mexican system, underscores the importance of practicum-based training in developing professional competence, a finding echoed in the Moroccan context by Bouabdallah, Ayoujil, and Reda Tazi

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(2019), whose assessment of the recruitment of contractual science teachers in the Oriental region highlights persistent gaps in the practical and pedagogical preparation of newly recruited teachers, gaps that appropriately designed AI-based training tools might help to address.
Investing in teacher training and professional development is one of the most critical solutions to Morocco's education challenges. The Moroccan government is working on providing more training opportunities for teachers to enhance their teaching skills and learn new approaches to teaching, and it incentivises teachers to work in rural areas.

2.2 Digital Infrastructure and National Strategies

In March 2005, the Government adopted a strategy aimed at promoting the widespread use of ICT in public education, whose implementation at primary and secondary school level was intended to ensure access to ICT resources and services for more than 22% of the Moroccan population. The GENIE programme (The Widespread Adoption of Information and Communication Technologies in Education in Morocco) constitutes the operational dimension of this strategy (Kabbaj, Talbi; 2009). Launched in early 2006 and revised in 2009, the programme covers all schools in the Kingdom and comprises four main components: the active participation of teachers in the integration of ICT into teaching; the improvement of teaching and learning quality through the pedagogical use of ICT; and the appropriation of multimedia tools by teachers with a view to their effective classroom use. Alongside this official GENIE training course, other training courses have been launched in several AREFs as part of pilot projects for experimenting with digital resources (SIVECO, RUBICON, CADWARE, SMART) or as part of educational partnerships (ALEF-USAID; USAID, 2020), Microsoft, Koica-South Korea.
Launched in February 2024, the Morocco DigiSchool project aims to empower students and teachers nationwide with digital skills and provide training in advanced technologies such as artificial intelligence, virtual reality, and web and app development, aligned with the GENIE Programme and the Digital Morocco 2030 strategy (Huawei, 2024). Morocco DigiSchool offers both online and offline sessions for training teachers in new technologies and pedagogical tools, along with follow-up activities to monitor implementation in classroom scenarios, thereby supporting education equity and inclusion in the face of unequal access to digital infrastructure, especially in rural areas (International Private School of Technology, 2025). Furthermore, Moroccan firms have high internet connection; in 2019, the average access rate for micro-organizations was 81%, for SMEs it was 97.9%, and for big enterprises it was 99.5%. With 92% of businesses using it, email continues to be the primary usage of the internet. Other uses, however, are still less common. According to the most recent data from the Office of the High Commission for Planning, 38% of enterprises do not utilize document access and editing, and only 59% of them use specific business software.[1]
The 2015-2030 Strategic Vision in Morocco aims to reform the educational system by improving equity and quality, with a key component being the renovation of teaching professions, including through the National Strategy of Continuing Education (SNFC), which seeks to make professional development a central part of a teacher's career (Kingdom of Morocco, Ministry of National Education, 2019). Maroc Digital 2030 sets out a vision for modernising the Moroccan economy and public services through digital innovation, with artificial intelligence and digital-talent development among its core pillars, while a "training-the-trainer" model ensures the scalability and sustainability of digital learning initiatives. More broadly, this digitalisation drive echoes findings from comparative research on digital

[1] *High Commission for Planning. (2022, February 1). Intégration des TIC au niveau entreprises au Maroc [Integration of ICT at the enterprise level in Morocco].* https://www.hcp.ma/Integration-des-TIC-au-niveau-entreprises-au-Maroc_a3370.html

transformation in Moroccan education, which similarly identifies infrastructure and teacher preparedness as the two principal bottlenecks to be addressed (Radouane, 2020).

Table 1: Government initiatives and strategies related to teacher training and digital literacy in Morocco

Government initiative or strategy	Objective of the initiative
Digital Education Projects	Government-led projects to integrate digital tools and train teachers, such as the "Development of Digital Education in Schools" project.
JAZARI Network	A platform dedicated to artificial intelligence that facilitates interactions between universities and innovators.
National Education Digital Lab	An incubator for educational solutions and new learning approaches, mobilising public and private players to develop and deploy digital solutions accessible to all Moroccan students.
YouCode Programme	A free, inclusive coding school for individuals aged 18 to 35, run as a partnership between OCP and Simplon, using project-based, peer learning.
Digital Classroom Project	Combines distance and face-to-face learning with digital tools to guarantee continuity of instruction, particularly for science subjects.
JobInTech	A national initiative supported by the Ministry of Digital Transition, aiming to boost the employability of young talent in the IT sector through intensive reskilling bootcamps.
Massar	A digital platform managing the academic progress of about 12 million students, including registration, tracking and school-reorientation services.
Teacher training and digital literacy	Efforts to improve teachers' skills in using digital tools; about 140 specialised digital programmes have been created in Moroccan universities.

Source: Authors' elaboration, based on Kabbaj et al. (2009), Huawei (2024), Médias24 (2024), Africa Tech Schools (2025), International Private School of Technology (2025), SMIATECH (2025), and JobInTech Academy (2025).

Table 1 shows that most government initiatives converge on two objectives, namely digital-skills training and infrastructure deployment, but the table also reveals a fragmentation of effort across at least seven distinct programmes, each operating under a different ministry or partner, without an explicit, shared framework specifically dedicated to preparing teachers to use AI. This redundancy of platforms, combined with the near-absence of AI-specific teacher-training objectives among these initiatives, constitutes a structural gap that the integration framework proposed in Section 6 seeks to address.

2.3 Main Challenges Facing the Digitalisation of Education in Morocco

Despite noticeable progress in the field of digital education, several challenges continue to hinder the development of this sector in Morocco.

Table 2: Main challenges facing the digitalisation of education in Morocco

Challenge	Description
The digital divide	A significant disparity in access to technology persists between major cities, where advanced infrastructure supports digital tools, and remote areas, where students and teachers face shortages of equipment and unreliable internet connectivity, hindering equitable access to digital education.
Adapting to technology	Many schools and teachers require intensive training to use digital tools effectively; a significant number of teachers lack the necessary digital skills, and adapting teaching methods to technology-intensive approaches requires substantial time and effort.
Infrastructure challenges	The technological infrastructure in many Moroccan schools remains insufficient, with most schools lacking necessary equipment such as computers and tablets, and with internet connectivity in many areas remaining slow or unstable.

Source: Authors' elaboration, based on UNESCO, the World Bank, and the World Economic Forum reports on education technology and infrastructure.

Taken together, the initiatives and challenges presented in this section indicate that, while Morocco has built a relatively dense ecosystem of digital-education programmes, most remain

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oriented toward general digital literacy and infrastructure rather than toward the AI-specific pedagogical and ethical competencies that teacher training must now address. This gap motivates the methodological and thematic analysis developed in Sections 3 to 5.

3. Methodological Framework and the Educational Dimension: Effectiveness and Quality

3.1 Methodological Protocol of the Literature Review

This article relies on a qualitative documentary methodology combining a review of official Moroccan and international policy documents (government strategies, ministerial reports, legal texts) with a purposive review of peer-reviewed academic literature on artificial intelligence in education. Sources were identified through targeted searches in academic databases, notably ScienceDirect, Springer and Google Scholar, using combinations of the keywords digital technologies, artificial intelligence, teacher training, ethics, equity, and Morocco or North Africa. Documents were included when they addressed, directly or indirectly, the moral, social or educational dimensions of AI in education or teacher training; purely technical computer-science publications without an educational or ethical dimension were excluded.

3.2 AI Applications in Teacher Training

Generative artificial intelligence is reshaping education by introducing tools that enhance teaching methodologies, personalise learning, and streamline administrative tasks (Davin et al., 2025). AI is revolutionising teacher training through diverse technological applications that enhance both the learning experience and pedagogical preparation. Intelligent tutoring systems provide personalised guidance to teacher learners, adapting content delivery based on individual progress and learning styles, while offering immediate feedback that accelerates skill acquisition and helps achieve personalised and efficient teaching guidance (Feng, Lai, Zhang, Fan, & Du, 2025).

Moreover, speaking of intelligent tutoring systems, technology has played a transforming role in redefining how we teach and learn. Intelligent Tutoring Systems (ITS) emerge as a powerful tool in the digital educational evolution, offering students tailored, adaptive learning experiences (Mousavinasab et al., 2021). These systems leverage artificial intelligence and machine learning to provide personalised feedback and guidance, addressing each learner's unique needs and pacing, with a positive impact on students' learning (Kulik & Fletcher, 2015). This positive impact is consistent with earlier comparative evidence showing that intelligent tutoring systems can approach the effectiveness of one-to-one human tutoring under certain conditions (VanLehn, 2011), which further supports their relevance for teacher training contexts characterised by limited access to individualised mentoring.

More than that, virtual reality and simulation technologies create immersive practice-teaching environments where prospective teachers can experiment with classroom management strategies, test different pedagogical approaches, and receive constructive feedback without the pressure or consequences of real classroom settings. These simulated experiences allow teacher trainees to encounter diverse student scenarios, including challenging behavioural situations and differentiated learning needs, building confidence and competence before entering actual classrooms.

AI-powered content curation and lesson-planning tools are transforming how teachers prepare instructional materials by analysing several educational resources and recommending age-appropriate, curriculum-aligned content matching specific learning objectives. Automated assessment and feedback systems further enhance training efficiency by evaluating teacher performance on assignments and providing detailed, criteria-based feedback that highlights strengths and areas for improvement, enabling teacher learners to refine their practice

continuously. However, the global movement toward integrating AI into educational areas presents abundant possibilities to experiment with novel approaches attuned to aspirations for learning pathways (Nejjari & Hammou, 2024).

Nejjari and Hammou (2024), whose study specifically addresses AI and education in the Moroccan context, similarly emphasise that Moroccan teachers show cautious openness toward AI tools but require structured training and clear institutional guidance to use them effectively and ethically, a finding consistent with the emphasis this article places on structured, multi-stakeholder integration frameworks (see Section 6).

3.3 Enhancing Training Effectiveness

The integration of AI into teacher training programmes enables unprecedented levels of personalisation through adaptive learning paths that respond to individual teacher needs, prior knowledge, and professional development goals (Lucas et al., 2025). Unlike traditional one-size-fits-all approaches, AI systems can identify specific competency gaps, recommend targeted learning modules, and adjust the pace and complexity of content to optimise each teacher's learning journey. Real-time performance analytics provide both trainers and teacher learners with comprehensive dashboards that track progress across multiple competencies, identify patterns in learning behaviours, and predict potential challenges before they become obstacles.

Furthermore, this emphasis on continuous, data-driven feedback echoes long-standing evidence in educational research that timely, specific feedback is among the most powerful levers of learning and professional improvement (Hattie & Timperley, 2007), a principle that AI-based analytics operationalise at a scale and frequency that traditional supervision cannot easily achieve. These data-driven insights empower teachers to take ownership of their professional development while enabling training institutions to allocate support resources more effectively and intervene proactively when learners struggle.

Adaptive curriculum-delivery systems ensure that training content remains relevant and appropriately challenging by continuously adjusting to learner responses and engagement levels, preventing both boredom from overly simple material and frustration from excessive difficulty. Microlearning and just-in-time support features deliver bite-sized, focused learning experiences that teachers can access precisely when needed, whether preparing for a challenging lesson, addressing a classroom management issue, or exploring a new pedagogical strategy. By providing accessible, relevant support at the moment of need, AI systems bridge the gap between theoretical training and practical classroom application, ultimately leading to more confident, competent and adaptive educators.

3.4 Challenges to Educational Quality

Currently, various AI-based innovations, tools and technologies are being used to facilitate the learning process and make it more practical; however, their application in the education sector raises concerns among teachers, for whom adopting AI may be challenging even though it is ultimately viewed as necessary for the continuity of education (Aljemely, 2024). Despite the promising benefits of AI integration, significant concerns exist regarding potential negative impacts on educational quality, particularly the risk of over-reliance on technology that may diminish essential human elements of teaching and learning. When teacher training becomes excessively dependent on AI systems, there is a danger that prospective teachers may develop a mechanistic approach to education, viewing teaching as primarily a technical skill rather than a nuanced, relationship-based profession requiring empathy, intuition and contextual judgment (Aljemely, 2024).

Furthermore, there exists a fundamental tension between superficial learning and deep understanding in AI-enhanced training environments, where the efficiency and speed of digital

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platforms may prioritise content coverage over meaningful engagement with complex educational concepts. Teacher learners might successfully complete numerous micro-modules and achieve high scores on automated assessments while failing to develop the profound pedagogical content knowledge, ethical reasoning and reflective practice capacities that distinguish excellent teachers. The risk is that AI-enhanced training, if not carefully designed and implemented, may produce teachers who are technically proficient but pedagogically shallow, capable of executing prescribed strategies but unable to adapt creatively to the unpredictable, human-centred challenges that define authentic teaching practice.

4. The Moral Dimension: Ethics and Responsibility

4.1 Ethical Principles for AI in Teacher Training

The integration of artificial intelligence into teacher training programmes must be grounded in fundamental ethical principles that ensure technology serves human flourishing rather than compromising it. The principles of beneficence and non-maleficence require that AI systems actively contribute to teacher development and educational improvement while carefully avoiding harm to learners, whether through privacy violations, biased assessments, or psychological stress induced by constant surveillance and evaluation (Jobin, Ienca, & Vayena, 2019). These principles demand that every AI application in teacher training undergoes rigorous ethical review to ensure its benefits substantially outweigh potential risks, and that safeguards exist to protect vulnerable teacher learners from exploitation or unfair treatment. Respect for autonomy and dignity requires that AI systems enhance rather than diminish teacher agency, supporting professional judgment rather than replacing it.

Besides, justice and fairness principles mandate that AI integration must not create or exacerbate inequalities among teacher learners, requiring deliberate attention to ensure that technological advantages are distributed equitably across regions, socioeconomic backgrounds, and demographic groups. Transparency and explainability are essential ethical requirements, particularly where automated decisions about teacher competence, progression and certification can profoundly affect careers and lives (Floridi et al., 2018). Teacher learners have a fundamental right to understand how AI systems evaluate their performance, what data informs algorithmic recommendations, and through what processes decisions affecting their professional futures are made.

4.2 Data Ethics and Privacy

AI-powered teacher training systems collect extensive data, including learning performance metrics, interaction patterns, video recordings of practice teaching, written assignments, assessment scores, behavioural indicators, and sometimes biometric information such as eye-tracking or emotional recognition data. This comprehensive data collection, while potentially valuable for personalised support, raises significant privacy concerns that must be addressed through robust ethical frameworks and legal compliance.

Moroccan Law No. 09-08 on the protection of personal data establishes important safeguards requiring that personal data collection be necessary, proportionate and transparent, with explicit consent from data subjects and strict limitations on data retention and secondary use (Kingdom of Morocco, 2009). Teacher training institutions implementing AI systems must ensure full compliance with these national legal requirements while also considering international standards such as the GDPR, particularly when collaborating with international technology providers or cloud-based platforms that may store data across borders (European Union, 2016). For instance, the Massar platform, which centralises the academic data of millions of Moroccan students nationwide (see Table 1), illustrates concretely the tension between institutional needs for large-scale data processing and the individual privacy rights protected under Law 09-08;

extending comparable data-governance safeguards to AI-based teacher-training platforms would operationalise the ethical principles discussed above in a tangible, Moroccan-specific manner. Consent protocols must be genuinely informed, ensuring that teacher learners understand not only what data is collected but how it will be analysed, who will have access, how long it will be retained, and what implications it may have for their evaluation and career progression.

Moreover, ethical data governance requires clear policies balancing institutional needs for programme evaluation with individual rights to privacy and data sovereignty, including provisions for data access, correction, deletion and portability (Tsai, Perrotta, & Gašević, 2020). Additionally, special protections are needed for sensitive data such as video recordings of teaching practice, which capture not only the teacher learner's performance but also potentially identifiable information about students in their classrooms.

4.3 Algorithmic Ethics

Algorithmic bias represents one of the most serious ethical challenges in AI-enhanced teacher training, as machine learning systems can inadvertently perpetuate and amplify existing social inequalities through biased training data, flawed model assumptions, or discriminatory pattern recognition. Documented cases of biased algorithmic outputs in other domains, for example, gender and skin tone related accuracy disparities in commercial facial-analysis systems (Buolamwini & Gebru, 2018), and the broader diagnosis of how opaque, poorly audited algorithms can systematically disadvantage already vulnerable populations (O'Neil, 2016), illustrate the type of harm that bias-detection and mitigation strategies in AI-based teacher training must guard against. Bias detection and mitigation strategies must therefore be embedded throughout the AI development lifecycle, from initial data collection ensuring diverse representation to ongoing monitoring that identifies disparate impacts on different demographic groups.

In the Moroccan context, algorithms must be scrutinised for potential biases related to language proficiency (favouring French or Arabic speakers over Tamazight speakers), geographic origin (urban versus rural backgrounds), gender (stereotypical assumptions about teaching subjects or styles), and socioeconomic status. Cultural sensitivity in algorithm design requires that AI systems reflect Moroccan educational values, social norms and pedagogical traditions rather than uncritically importing Western or culturally inappropriate assessment criteria.

Accountability for AI decisions must be clearly established, with human oversight mechanisms ensuring that no teacher learner faces adverse consequences, such as failing evaluations, denied certifications, or blocked career progression, based solely on automated assessments without meaningful human review, explanation, and opportunity for appeal (Dignum, 2019). This accountability framework should identify responsible parties who can be held answerable when AI systems malfunction, produce discriminatory outcomes, or otherwise fail to meet ethical standards.

4.4 Professional Ethics and Moral Responsibility

Teachers bear a fundamental duty of care toward students, a moral responsibility that extends beyond mere instructional competence to encompass the holistic well-being, dignity and developmental needs of every learner. Teacher training programmes integrating AI must explicitly address how this duty of care operates in technology-mediated educational environments, preparing teachers to protect students from potential harms associated with educational technology, including privacy violations, algorithmic bias, and depersonalised learning experiences.

Critical AI literacy emerges as a moral imperative for contemporary teachers, who must understand not only how to use educational technology but also how to evaluate it critically,

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recognise its limitations and biases, and advocate for students when algorithmic systems produce unjust outcomes. Ethical oversight mechanisms are essential components of a responsible AI integration framework, providing safe channels for teachers, trainers and other stakeholders to report concerns about unethical AI applications, discriminatory outcomes, or institutional pressures to prioritise technological efficiency over educational quality, thereby creating a culture of accountability that reinforces moral responsibility throughout the educational ecosystem.

5. The Social Dimension: Equity and Inclusion

5.1 Access and the Digital Divide

Morocco's geographic diversity creates significant disparities in access to AI-enhanced teacher training, with stark contrasts between well-resourced urban centres and underserved rural and remote areas (World Bank, 2020). Urban regions, particularly Casablanca and Rabat, typically enjoy reliable internet connectivity, modern training facilities, and access to technical support personnel, whereas rural and remote areas often lack basic technological prerequisites for AI integration, including stable electricity supply, adequate internet bandwidth, and physical devices capable of running sophisticated AI applications. These infrastructure barriers create a two-tiered teacher training system in which prospective teachers from privileged urban backgrounds gain experience with cutting-edge educational technology while their rural counterparts receive traditional training that may inadequately prepare them for increasingly digitalised classrooms.

Economic constraints compound geographic inequalities, as prospective teachers from lower socioeconomic backgrounds may lack personal devices or the means to afford internet connectivity for independent study (ITU, 2021). Language barriers add another layer of complexity, as many AI systems are designed primarily for English, French or Modern Standard Arabic, potentially disadvantaging speakers of Moroccan Arabic (Darija) and Tamazight varieties, who may struggle with interface languages or find that AI assessment systems penalise their linguistic backgrounds (Ennaji, 2005). This concern resonates with long-standing research on the pedagogical value of mother tongue-based instruction (Benson, 2004), which suggests that AI systems failing to accommodate Darija or Tamazight risk undermining, rather than supporting, equitable learning outcomes for both teachers and students.

Nonetheless, this linguistic dimension of the digital divide is particularly significant in Morocco's multilingual context, where language-of-instruction policies remain contested and where teachers' linguistic repertoires may not align with the language assumptions embedded in imported AI technologies. Addressing these multifaceted access barriers requires comprehensive strategies that go beyond simply providing devices to include infrastructure development, linguistic localisation, financial support for disadvantaged learners, and alternative training pathways that do not presume universal technological access.

5.2 Social Equity Concerns

The integration of AI into teacher training carries significant risks of exacerbating socioeconomic stratification within the teaching profession, potentially creating hierarchies where technologically proficient teachers command better positions, higher salaries and greater professional opportunities, while those lacking digital skills or access face marginalisation (Warschauer & Matuchniak, 2010). Gender disparities in technology access represent another critical equity concern, as sociocultural factors in Morocco may limit women's access to technology training, or impose constraints on women's ability to reach training facilities that require extensive time commitments or travel to urban centres (Kingdom of Morocco, Ministry of National Education, 2019).

Special-needs and inclusive-education considerations are often overlooked in AI system design, yet teacher training programmes must ensure that AI tools are accessible to learners with visual, hearing, motor or cognitive disabilities. Age and generational gaps among teachers present additional equity challenges, as younger teacher learners who grew up with digital technology may adapt more easily to AI-enhanced training, while older career-changers or returning teachers face steeper learning curves (Holstein & Doroudi, 2021).

Among the equity concerns identified in this section, geographic and infrastructural access disparities and linguistic barriers appear, on the basis of the sources reviewed, to be the most immediately consequential for AI integration in Moroccan teacher training, given their direct bearing on whether teachers can access training at all. Gender and generational disparities, while significant, more often affect the depth and comfort of engagement with AI tools rather than access itself, and age based digital literacy gaps appear comparatively more tractable through targeted, short-term training interventions. This tentative hierarchy, proposed on the basis of the reviewed literature, would benefit from empirical validation through primary data collection, as noted in the Conclusion.

5.3 Social Impact on the Teaching Profession

With the growth of AI use, anxieties have begun to appear among communities about technology's impact on professional work across sectors, with particular significance in education, where the quality of human relationships, contextual sensitivity and ethical judgment are central to effective practice. Employment concerns and job-transformation fears are widespread among current and prospective teachers who worry that AI might eventually reduce demand for teaching professionals or transform the role so fundamentally that their training and experience become obsolete (Selwyn, 2019).

Teacher unions and stakeholder perspectives on AI integration vary widely, with some advocating for embracing technology as an opportunity to enhance professional practice and working conditions, while others resist what they perceive as corporate technology encroachment into education driven by profit motives rather than pedagogical values (Williamson & Eynon, 2020). The social status and recognition of teachers may shift as AI changes perceptions of teaching expertise (Prinsloo & Slade, 2017); if teaching comes to be seen as primarily a technical skill in managing AI systems rather than sophisticated professional judgment, the profession's social prestige may decline. Conversely, if AI integration is framed as enhancing teachers' professional capabilities, it could elevate teaching's status as a knowledge-intensive, technologically sophisticated profession requiring continuous learning and adaptation.

5.4 Synthesis of the Moral, Social and Educational Dimensions

Table 3: Synthesis of the moral, social and educational dimensions of AI integration in Moroccan teacher training

Dimension	Central issues	Illustrative Moroccan example	Principal tension
Educational (Section 3)	Personalisation, effectiveness, risk of superficial learning	Intelligent tutoring systems and adaptive learning platforms in CRMEF training	Efficiency of AI-driven training versus depth of pedagogical content knowledge
Moral (Section 4)	Beneficence, autonomy, data privacy, algorithmic bias	Law 09-08 and the governance of platforms such as Massar	Institutional need for data versus individual privacy and autonomy
Social (Section 5)	Digital divide, linguistic and gender disparities	Rural/urban and Darija/Tamazight access gaps	Democratisation of AI access versus the risk of reproducing existing inequalities

Source: Authors' elaboration, based on the analysis developed in Sections 3 to 5.

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The previous table is showing how the introduction of AI into Moroccan education is not a purely technical question. It creates simultaneous educational, ethical and social dilemmas. Each of these dilemmas is illustrated with a specifically Moroccan case, showing that the tensions are local and concrete rather than abstract. The table therefore serves as a structured analytical framework for discussing how Morocco can adopt AI in education without sacrificing pedagogical depth, individual rights, or social equity.

6. Integration Framework: Toward Responsible Implementation

6.1 Strategic Integration Model

Responsible AI integration into Moroccan teacher training requires a multi-stakeholder approach that brings together teacher educators, prospective and practising teachers, technology developers, education policymakers, civil society organisations, and community representatives. More than that, this inclusive approach ensures that implementation decisions reflect authentic needs rather than being driven solely by technological possibilities or administrative efficiency goals. A phased implementation timeline is essential to avoid overwhelming institutions, allow learning from early experiences, and enable course corrections before problems become entrenched, beginning with small-scale pilot projects in diverse contexts before expanding to widespread adoption.

Pilot projects should be strategically selected to represent Morocco's diversity, including urban and rural settings, and Francophone, Arabophone and Anglophone institutions, ensuring that lessons learned reflect varied realities rather than privileged circumstances. These pilot initiatives should operate as genuine experiments with rigorous evaluation protocols, protected space for innovation and failure, and explicit mechanisms for capturing lessons learned and disseminating insights to inform broader implementation.

Nonetheless, to move from general principle to operational guidance, a realistic phased calendar might comprise an 18 to 24 month pilot phase in a limited number of CRMEF centres (for example, two urban and two rural centres, selected to include Arabic-, French- and Amazigh-speaking regions), coordinated jointly by the Ministry of National Education, the CRMEF network, and the Digital Development Agency; a subsequent evaluation phase of 6 to 12 months relying on indicators such as teacher AI-literacy gains, equity of access across pilot sites, and reported ethical incidents; and, contingent on a positive evaluation, a phased national rollout over a further three-to-five-year period. Budgetary and staffing figures are necessarily indicative at this stage and should be specified through consultation with the relevant ministries and, where applicable, technology partners.

6.2 Institutional Capacity Building

Infrastructure development priorities must address both physical and human dimensions, including reliable electricity and internet connectivity, adequate computing devices and software, secure data storage systems, and technical support personnel capable of maintaining AI systems. In the Moroccan context, infrastructure investment cannot focus exclusively on privileged urban institutions but must include strategic development of rural and underserved areas. Training AI specialists and support staff represents a critical medium-term investment, developing Moroccan expertise in educational AI rather than creating permanent dependence on external consultants or foreign technology companies. Creating centres of excellence in AI-enhanced teacher education can serve as hubs for innovation, research and professional development, providing demonstration sites, experimentation spaces, and training facilities for teacher educators across Morocco.

Moreover, partnerships with the technology industry and universities are essential for accessing cutting-edge AI developments (Holmes, Persson, Chounta, Wasson, & Dimitrova, 2022),

provided that these partnerships are structured carefully to ensure that educational values and local needs drive technology application rather than commercial interests, and that capacity is genuinely built locally rather than creating dependency relationships disguised as partnerships.

6.3 Pedagogical Integration Guidelines

Hybrid models combining AI capabilities with human expertise represent the most promising approach to teacher training, leveraging technology's strengths in personalisation, scalability and data analysis while preserving the human elements of mentorship, contextual judgment and ethical guidance (African Union, 2020). These models position AI as a tool supporting human teacher educators rather than replacing them, with AI handling routine assessment, content delivery and performance tracking, while human educators provide mentorship, model pedagogical reasoning, and address complex ethical and interpersonal dimensions of teaching.
Teacher support systems must accompany AI integration to help both teacher educators and teacher learners navigate technological change, including accessible technical assistance, pedagogical guidance, emotional support for those experiencing anxiety about technology, and spaces for critical dialogue about AI's appropriate role in education. Continuous improvement cycles should be built into implementation frameworks, with regular collection of feedback from users and mechanisms for rapid adjustment when problems emerge.

6.4 Theoretical Anchoring of the Integration Model

The integration framework proposed above can usefully be anchored in two established theories of technology adoption and organisational change. The Technology Acceptance Model (Davis, 1989) suggests that teachers' adoption of AI-based training tools will depend primarily on their perceived usefulness and perceived ease of use, two dimensions that the phased, hybrid approach recommended above is designed to strengthen through pilot demonstration and sustained technical support.
Complementarily, Rogers' diffusion-of-innovation framework highlights the role of early adopters, opinion leaders and observability in the spread of an innovation across a social system; applied to the Moroccan CRMEF network, this suggests that visible, well-documented pilot successes in a small number of centres are likely to be a more effective lever for national diffusion than a simultaneous, system-wide rollout. Anchoring the integration model in these frameworks strengthens its scientific grounding and provides testable propositions, for example regarding the relationship between perceived usefulness and adoption rates, for future empirical research.

7. Conclusion

This article set out to examine, through a qualitative documentary review of official Moroccan documents and peer-reviewed literature, the conditions under which artificial intelligence can be integrated into teacher training in Morocco while preserving educational quality, ethical standards and social equity. Three main findings emerge from this review. On the educational dimension, AI-based tools such as intelligent tutoring systems, adaptive learning platforms and automated feedback mechanisms offer genuine potential to personalise teacher training and to accelerate the acquisition of pedagogical competencies, but this potential is accompanied by a real risk of technically proficient yet pedagogically shallow training if depth of engagement is sacrificed to efficiency. On the moral dimension, the principles of beneficence, autonomy, justice and transparency provide a coherent ethical grounding for AI integration, and Morocco already possesses a relevant legal basis in Law 09-08 on personal data protection; yet this legal framework remains insufficiently operationalised in existing AI-based educational platforms such as Massar, and algorithmic bias linked to language, region and gender remains inadequately monitored. On the social dimension, the digital divide, linguistic diversity (Arabic,

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French, Darija, Tamazight), and gender and generational disparities constitute the most consequential barriers to equitable AI integration in teacher training, ahead of concerns, however legitimate, about the wholesale replacement of teachers by AI.

The Moroccan government aims to modernise its educational system through several strategies and initiatives focused on integrating technology into teaching and learning processes, and the Ministry of National Education is pursuing the implementation of digital tools at all levels of the educational system. Building on this policy momentum, the principal contribution of the present article lies in proposing an integrative conceptual model, anchored in the TPACK and AI4People frameworks (Section 1.5), together with a phased, multi-stakeholder integration framework theoretically grounded in the Technology Acceptance Model and Rogers' diffusion-of-innovation theory (Section 6.4), that connects the moral, social and educational dimensions of AI integration in a manner specifically adapted to the Moroccan context, an articulation that, to the authors' knowledge, had not previously been proposed in the literature on AI and teacher training in North Africa.

This study is nonetheless subject to several limitations. First, the literature review does not follow a fully documented systematic protocol in the sense of Kitchenham (2004), and should therefore be read as a qualitative, thematic documentary review rather than a systematic review in the narrow sense. Second, the analysis relies exclusively on documentary sources and does not include primary empirical data, such as interviews or surveys with Moroccan teachers, teacher-trainers, or CRMEF officials, which limits the extent to which the moral, social and educational concerns identified can be considered empirically validated for the Moroccan context specifically, as opposed to inferred from international literature and applied to Morocco by analogy. Third, the connectivity and infrastructure statistics mobilised in Section 2.2 originate from heterogeneous sources and periods, which limits their comparability and should be interpreted with appropriate caution.

These limitations point toward several avenues for future research. Empirical studies based on surveys or interviews with CRMEF trainers and trainee teachers would allow the moral, social and educational concerns identified here to be tested against the lived experience of Moroccan teacher training. Case studies of pilot AI-integration projects, once implemented along the lines proposed in Section 6, would provide an opportunity to test empirically the propositions derived from the Technology Acceptance Model and the diffusion of innovation framework. Finally, comparative research examining AI integration in teacher training across other North African or Arab countries would help determine which of the challenges identified in this article are specific to Morocco and which reflect broader regional or linguistic dynamics.

Nonetheless, from a practical standpoint, this review suggests several recommendations addressed to the main stakeholders of Moroccan teacher training. For the Ministry of National Education and the CRMEF network, it is recommended to pilot AI-based training tools in a limited number of centres representative of Morocco's linguistic and regional diversity before national rollout, and to embed explicit AI-ethics modules, covering data privacy, algorithmic bias and professional responsibility, into the CRMEF curriculum.

For technology partners and industry actors, it is recommended to prioritise the localisation of AI tools into Darija and Tamazight and to submit AI-based assessment systems used in teacher training to independent bias audits. For policymakers more broadly, it is recommended to extend the operational scope of Law 09-08 explicitly to AI-based educational platforms, and to establish an independent oversight mechanism, potentially housed within the Higher Council for Education, Training and Scientific Research (CSEFRS), through which teachers and trainees can report concerns regarding AI-based evaluation without fear of professional retaliation. Taken together, these measures would help ensure that the integration of artificial intelligence into Moroccan teacher training strengthens, rather than undermines, the human

elements, creativity, ethical reasoning and critical thinking, that remain the essential cornerstone of education.

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