

Towards a New Artificial Intelligence-based Framework for Teachers' Online Continuous Professional Development Programs: Systematic Review

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Abstract—In recent years, the Artificial Intelligence (AI) field has witnessed rapid growth, affecting diverse sectors, including education. In this systematic review of literature, we aimed to analyze studies concerning the integration of AI in the continuous professional development (CPD) of teachers in order to generate a global vision on its potential to enhance the quality of CPD programs in the international level, and to provide recommendations for its application in the Moroccan context. To achieve our objective, we conducted a research that involves a review of international indexed databases (Scopus, Web of Science, Eric) published between 2019 and 2023 using PICO framework to formulate our search query and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to select 25 relevant studies based on include and exclude criteria like publishing year, type of documents, publishing mode, subject area, language, and other criteria. The results reveal that AI integration has a positive impact on CPD programs by offering beneficial intelligent tools that can tailor adaptive training programs to meet teachers' specific needs, preferences, and proficiency levels. Furthermore, our findings identify the importance of integrating AI as a core topic within CPD programs to enhance teachers' AI literacy, enabling them to effectively navigate and utilize AI-based tools in their educational environment. This is important for preparing teachers to engage with the technological advances shaping the educational system. In conclusion, our systematic review emphasizes the significance of AI integration in CPD programs and offers tailored recommendations for its implementation in the Moroccan educational context. By adopting these recommendations, Morocco will pave the way for a dynamic CPD framework that meets the evolving needs of educators and students alike.

Keywords—Artificial intelligent; continuous professional development; Moroccan in-service teacher; digital teacher; online training; adaptive development

I. INTRODUCTION

Artificial Intelligence (AI) involves creating computer systems capable of tasks requiring human-like intelligence. These tasks include learning, reasoning, problem-solving, perception, language understanding, speech recognition and other abilities. AI is a broad and interdisciplinary field that encompasses various subfields and approaches, it has a profound impact on various sectors, including education, by

having a significant impact, offering innovative solutions to enhance teaching, and learning experiences.

In this study, we focused on investigating the impact of AI on teachers' education and its potential to improve the quality of continuing professional development (CPD) programs, which are essential for enhancing teachers' skills and ultimately student learning outcomes.

Our primary objective is to identify how AI can be seamlessly integrated into CPD as an innovative technology that aid trainers by offering tailored and adaptive training programs, addressing teachers' specific needs to develop new skills for more effective teaching performance. Additionally, we aimed at exploring strategies to develop teachers' AI literacy to ensure they remain up to date with the latest novelties in the field.

To achieve this objective, a systematic review of numerous studies collected from universal and reputable databases was conducted, employing inclusion and exclusion criteria. Subsequently, through the analysis of our selected studies, a framework was derived for an effective integration of AI in CPD programs within the Moroccan context.

The necessity for developing AI-driven framework stems from the significant dropout rates observed in conventional training programs for educators, indicating their inadequacy in delivering effective results. In response to this challenge, we have embraced a framework that offers personalized, data-driven, and technologically advanced learning experiences that empower educators in an ever-evolving educational landscape.

Following the review and examination of the 25 studies included in our research, we identified three key themes addressed within them. These themes encompass the inclusion of AI as a topic within online Continuous Professional Development (CPD), its utilization as a scaffolding instrument, and the proposed guidelines for defining the competency profile of a "digital teacher."

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II. LITERATURE REVIEW

A. Artificial Intelligence

Artificial intelligence (AI) is the simulation of human intelligence in machines programmed to think and learn like humans [1]. The goal of AI is to create systems capable of performing tasks that typically require human intelligence [2], such as visual perception, speech recognition, decision making, and language translation. AI can be divided into two main categories: narrow or weak AI, and general or strong AI.

1) *Narrow AI (Weak AI)*: This type of AI is designed and trained for a specific task. It excels in that specific area but lacks the broad cognitive abilities of a human. Examples include virtual personal assistants like Siri or Alexa, image recognition software, and recommendation algorithms [3].

2) *General AI (Strong AI)*: This is a hypothetical form of AI that has the ability to understand, learn, and apply knowledge across a wide range of tasks, similar to human intelligence [3]. AI includes several subfields, such as:

a) *Machine Learning (ML)*: A subset of AI that focuses on developing algorithms that allow computers to learn patterns from data without being explicitly programmed [4]. ML has the power to intelligently analyze such data and to develop the appropriate real-world applications [5].

b) *Natural Language Processing (NLP)*: Involves the interaction between computers and humans using natural language to make machines able to understand the statements and words written in human language [6], in order to generate language translation, sentiment analysis [7], and chatbots [8].

c) *Computer vision*: Enables machines to interpret and make decisions based on visual data [9], such as image and video recognition [10].

d) *Robotics*: Combines AI with physical machines to create intelligent robots capable of performing real-world tasks, and responding in ways similar to human social norms [11].

e) *Generative AI*: subset of artificial intelligence systems that are designed to generate new, original content or data. Unlike traditional AI systems that are rule-based or follow predetermined instructions, generative AI models are capable of producing outputs that were not explicitly programmed or predefined by their creators [12], rather than analyzing something that already exists [13].

“Generative AI refers to a class of artificial intelligence systems designed to generate new content or data that is similar to, but not an exact copy of, existing data. These systems are capable of producing original and creative outputs across various domains, such as text, images, music, and more.”¹

f) *Cloud computing*: refers to the delivery of computing services, including computing power, storage, databases, networking, software, and analytics, over the internet [14] to offer faster innovation and accessibility, flexible resources, and economies of scale [15] [16].

g) *Blockchain*: Blockchain is a decentralized and distributed ledger technology that enables secure, transparent, and tamper-resistant record-keeping of transactions across a network of computers [17]. It has the potential to revolutionize various industries by providing a decentralized and trustless way of recording and verifying transactions [18].

B. AI in Education

AI as a new technological revolution has emerged in many sectors including education. AI has the potential to revolutionize education by introducing innovative tools and techniques [19], to improve pedagogical methods and to enhance the learning experience [20], to personalize instructions [21], and streamline administrative tasks.

1) *Personalized learning*: AI systems can adapt to individual student needs, providing personalized learning experiences. This includes tailoring the pace, content, and style of instruction to suit each student's learning preferences and abilities [22] [23].

2) *Intelligent Tutoring Systems (ITS)*: Use AI to assess a student's strengths and weaknesses, offering targeted feedback and additional resources [24].

3) *Adaptive learning platforms*: AI-powered adaptive learning platforms adjust the difficulty level of content based on individual student progress, needs, and learning styles [25], [26]. This ensures that students are appropriately challenged and supported in their learning journey [27].

4) *Automated grading and feedback*: AI algorithms can automate the grading of assignments and assessments, saving teachers time and providing students with instant feedback [28]. This allows educators to focus on more meaningful aspects of teaching, such as facilitating discussions and offering personalized guidance [29].

5) *Virtual assistants and chatbots*: Virtual assistants and chatbots equipped with natural language processing capabilities can assist students in online courses by answering questions, providing information, and guiding them through learning materials [30] [31].

6) *Language translation and accessibility*: AI-powered language translation tools can help overcome language barriers, making educational content more accessible to learners around the world [32]. AI can also be used to assist learners with disabilities by providing real-time transcription, language translation, or other adaptive technologies [33].

7) *Educational games and simulations*: AI can enhance educational games and simulations by adapting to the learner's progress, ensuring that the challenges presented align with the student's skill level [34] [35].

8) *Mixed reality*: refers to a merging of the physical and digital worlds, combining elements of both augmented reality (AR) and virtual reality (VR) [36]. In mixed reality, users interact with and experience a blend of real-world and computer-generated environments and objects. This allows for a more immersive and interactive experience than what is possible with traditional forms of media [37].

¹ChatGPT 4, December 2023, on generative AI.

9) *Plagiarism checkers*: AI-based tools designed to identify and detect instances of plagiarism in written content. These tools compare a given text against a vast database of academic papers, articles, websites, and other sources to check for similarities in order to ensure the originality of students' work [38] [39].

10) *Topic modeling*: is a natural language processing (NLP) technique used to automatically identify topics present in a text corpus. It helps in discovering hidden thematic structures within a large collection of documents and is widely used for organizing, understanding, and summarizing textual information [40].

C. Teachers' Continuous Vocational Training

Continuing vocational training, also known as continuing professional development (CPD) or lifelong learning, refers to the ongoing process of acquiring new knowledge, skills, and competencies throughout one's career [41]. In today's working environment, where technological advances and industry requirements are rapidly evolving, continuing professional development is becoming increasingly crucial to enable individuals to remain relevant and competitive in their profession [42].

Continuous vocational training for teachers is crucial to stay current with advancements in teaching methodologies, technology, and educational research, in order to influence teaching practices, leading to improved quality of learning [43] and student outcomes. [44]

However, similar to every country, there are some limitations and challenges associated with the presential Continuing professional development in Morocco, such as,

- the Massification of teachers in comparison with the number of trainers, 281.662 teachers in 2023-2024².
- the availability, Teachers often have busy schedules with teaching responsibilities, grading, and extracurricular activities. Devoting time for vocational training can be challenging.
- Teacher assignment: Teachers who are assigned to work in remote areas, face with challenges related to transportation, given that the training centers are located in the center of cities.
- Monitoring: given the large number of teachers, it's difficult to monitor and support them individually face-to-face.
- The high-cost financial investment, related to the accommodation, organization and travelling of teachers and trainers.
- The needs of teachers: most vocational trainings are based on what is offered and not on real needs of teachers in their specific contexts [45].

In the realm of Continuing Professional Development (CPD), the digital age has brought about significant innovations, offering a solution to the challenges and limitations of traditional in-person training. Online platforms have revolutionized CPD by providing high flexibility in terms of timing, ensuring equal access to information regardless of users' geographic locations [46], and enabling the simultaneous support of a large number of teachers at minimal costs for both the ministry and teachers. [47] [48]

Despite these significant advantages, the digital CPD is not without its limitations. Issues such as monitoring, engagement, and motivation [49], persist, along with challenges related to assessment and the adaptation of learning content to cater to individual teacher's needs, levels, and preferences [26], this is mainly due to the absence of intelligent educational environments capable of analyzing teachers' profile in order to provide adaptive instructions and content similar to what can be given by a human brain or more. Unlike traditional e-learning platforms in which content delivery is static and feedback is programmed. The future of CPD lies in the development of intelligent systems that can mimic the adaptability and personalization offered by human instructors. These new systems help overcome the massification problem by supporting a large number of teachers while also addressing the flexibility issue by allowing educators to learn at their own pace and convenience in order to elevate the quality, efficacy and the credibility of the CPD programs.

In recent years, artificial intelligence (AI) has provided a large and diverse number of intelligent tools that address the limitations of traditional e-learning methods. To prepare digital teachers for intelligent educational environments, it is crucial to consider the following questions:

- How does integrating AI into CPD programs help prepare teachers in their teaching practices?
- Is incorporating AI-focused topics into professional development curricula considered a necessity?
- What are the recommendations to take into consideration to prepare digital teachers for intelligent educational environments?

III. MATERIALS AND METHODS

A. General Background

In this study, we aim for a systematic review that delves into the impact of AI on the quality of continuing professional development, shedding light on its contributions and implications. Our study was based on drawing insights from indexed articles and reviews from esteemed international databases (Scopus, Web of science (WoS), and ERIC). Using the PICO framework and logical operators (AND, OR, NOT), we elaborated a search question to guide our research endeavors.

²back-to-school 2023-2024 in numbers: <https://medias24.com/2023/09/06/la-rentree-scolaire-2023-2024-en-chiffres/>

B. Search Strategy

Following the PICO framework³, we meticulously constructed our search query. To ensure comprehensiveness, we identified a vast array of synonyms for the key study terms. These synonyms were drawn from credible sources encompassing articles, press releases, dictionaries, scholarly books, and conference proceedings. To capture all relevant information, we strategically employed logical operators (AND, OR, NOT) to combine these synonyms (as detailed in Table I). This meticulous approach aimed to maximize the potential results for our study.

TABLE I. KEYWORDS USED TO FORMULATE THE SEARCH QUERY

Artificial intelligence AND	OR artificial OR intelligence OR AI OR intelligent platforms OR intelligent tools OR AI-based tools OR intelligent technology OR intelligent algorithms
Online AND	OR distance OR networked OR web-based OR internet OR e-learning OR LMS
Teacher AND	OR In-service teachers OR practitioner teachers OR educator OR professor OR instructor OR coach OR tutor NOT pre-service NOT preservice NOT trainee teachers NOT future teacher
Continuous Professional Development	OR continuous OR vocational OR training OR continuous training OR continued training OR continuing training OR continual training OR ongoing training OR professional training OR professional development OR lifelong learning OR teachers' education OR vocational education
Search query	
ALL ("artificial intelligence" OR ai OR "intelligent platforms" OR "intelligent tools" OR "AI-based tools" OR "intelligent technology" OR "intelligent algorithms" AND online OR distance OR networked OR web-based OR internet OR e-learning OR lms AND teacher OR "in-service teachers" OR "practitioner teachers" OR educator OR professor OR instructor OR coach OR tutor AND NOT pre-service AND NOT preservice AND NOT "trainee teachers" AND NOT "future teachers" AND continuous OR vocational OR training OR "continuous training" OR "continued training" OR "continuing training" OR "continual training" OR "ongoing training" OR "professional training" OR "professional development" OR "lifelong learning" OR "teachers' education" OR "vocational education")	

C. Inclusion and Exclusion Criteria

To select the appropriate studies for our systematic review, we determined and respected the following inclusion and exclusion criteria.

D. Selection Strategy

1) *Quantitative filtering*: Following the formulation of our search query (Table I), we employed a quantitative selection approach, utilizing tools like RAYYAN⁴ software and MS EXCEL. we adhered to the PRISMA [50] framework to analyze and filter the found studies based on inclusion and exclusion criteria outlined in (Table II) above. For further details, see (Table III) below, identification section.

TABLE II. INCLUSION AND EXCLUSION CRITERIA

Including Criteria	Excluding Criteria
Indexed in Scopus, Web of Science, ERIC.	Not indexed in Scopus, Web of Science, ERIC.

³Pico Framework: <https://guides.lib.unc.edu/pico>

⁴Rayyan Software: <https://www.rayyan.ai/>

Published from 2019 to 2023.	Published prior to 2019.
Computer science and education subject areas	Other subject areas
English language.	Not in English.
Open access articles.	Not open access articles.
Research involving in-service school or university teachers.	Research not involving in-service teachers. Research involving pre-service teachers.
Articles, Reviews	Books, Book sections, Conference proceedings
Studies related to AI in teachers' CPD (AI with a focus on machine learning, data analysis, and natural language processing applications).	Studies not related to AI in teachers' CPD.

2) *Qualitative filtering*: After the quantitative filtering, we proceeded to a qualitative selection based on,

- Title analysis according to the presence of study's keywords.
- Abstract analysis based on sample and results.
- Content reading and synthesizing.

For more details, see (Table III) screening and eligibility sections.

TABLE III. DETAILS OF FILTERING PROCESS RESULTS, BASED ON PRISMA METHOD

	First research Based on search query	Scopus	WoS	ERIC	Total	Excluded
		1,959	2983	1753	6695	00
Identification	Filter 1 Date: 2019 – 2023	1812	2023	963	4798	1897
	Filter 2 Subject area: Computer science, education.	952	1422	522	2896	1902
	Filter 3 Document type: Articles, reviews.	617	920	415	1952	944
	Filter 4 keywords or tags.	457	883	231	1571	381
	Filter 5 Language: English.	456	864	215	1535	36
	Filter 6 open access articles: Gold.	182	315	126	623	912
Screening	Title analysis ✓ Duplicates. ✓ No mention of at least one of keywords. ✓ Retracted articles. Abstract analysis: ✓ wrong population.	90	67	45	202	421
Eligibility	Content analysis ✓ Articles not focusing on AI in online CPD.	70				132

Inclusion	25	45
Results		
Total included articles = 25	Total Excluded= 6670 articles	

The flow chart diagram which is given in Fig. 1 describes the filtering process based on PRISMA framework.

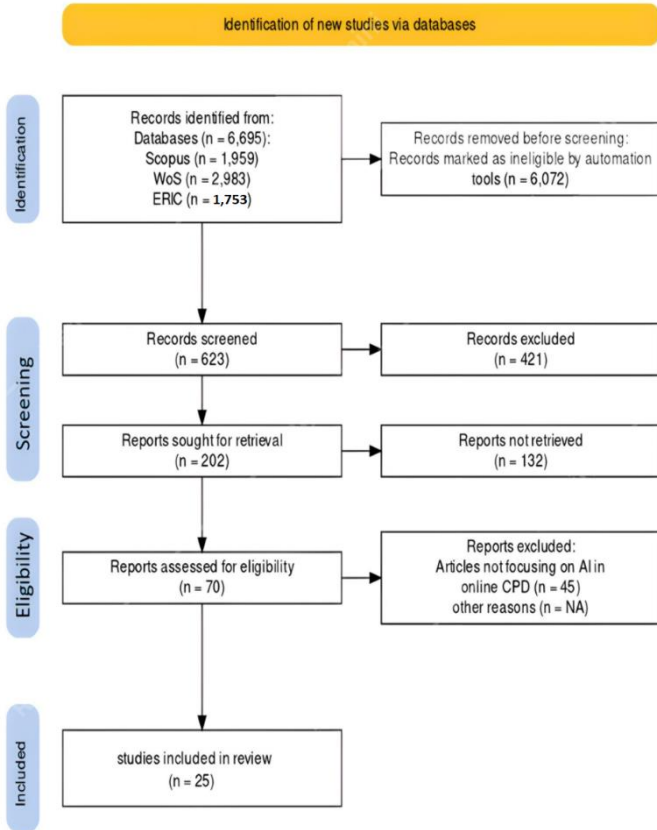


Fig. 1. PRISMA flow diagram.

IV. RESULT AND DISCUSSION

A. Statistical Description of the Included Studies

After proceeding our search request based on our keywords, and respecting PRISMA framework, we obtained 25 studies that respect our criteria (see Table IV) of inclusion, these articles are categorized according to:

1) Databases

TABLE IV. DIVISION OF THE INCLUDED STUDIES ACCORDING TO DATABASE SOURCE

Databases	Number of articles	Percent %
Scopus	14	56
WoS	8	32
ERIC	3	12

2) Publishing year: Fig. 2 below shows a representation of selected studies according to publishing year, most of studies are published in 2023 (40%), whereas, in 2020, only

one study has been found (4%). Hence, AI has taken the center of interest of many researchers as a new field recently.

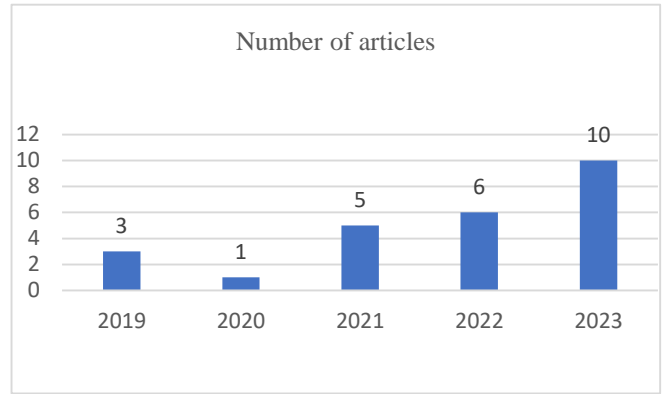


Fig. 2. Division of the included studies according to publishing year.

3) Countries: As shown in Table V and Fig. 3, China is having maximum number of included studies (28%), followed by USA (12%), then South Korea and Indonesia (8%),

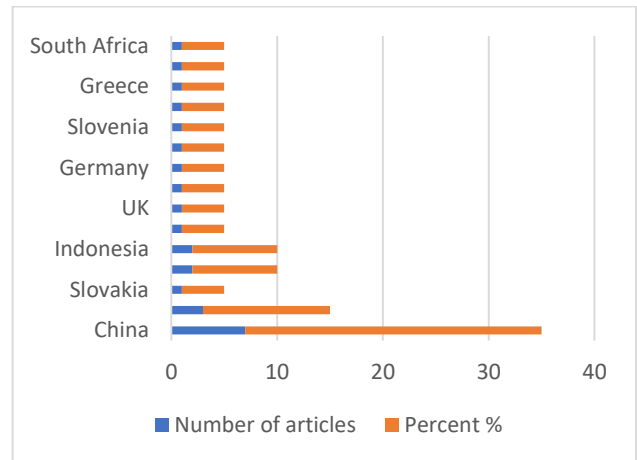


Fig. 3. Division of the included studies according to countries.

TABLE V. DIVISION OF THE INCLUDED STUDIES ACCORDING TO COUNTRIES

Country	Number of articles	Percent %
China	7	28
USA	3	12
Slovakia	1	4
South Korea	2	8
Indonesia	2	8
Turkey	1	4
UK	1	4
Lithuania	1	4
Germany	1	4
Chile	1	4
Slovenia	1	4
Nigeria	1	4

Greece	1	4
Kazakhstan	1	4
South Africa	1	4

4) Technology area

B. Factors for Including AI in Online CPD Programs Topics

Artificial Intelligence has become an increasingly important subject in the field of Continuous Professional Development (CPD), necessitating teachers to stay updated on the latest advancements and techniques to effectively integrate AI into their teaching practices [76]. This requires specialized training to navigate challenges and harness the potential of AI [68]. By keeping up with AI in CPD, teachers can leverage AI-based tools and services for supporting students by designing intelligent student support systems, personalizing learning environments [77], providing advanced writing assistance, and fostering creative thinking [51]. Table VI shows division of the included studies whereas Table VII shows recap of the included studies.

TABLE VI. DIVISION OF THE INCLUDED STUDIES ACCORDING TO TECHNOLOGY AREA

Technology Area	Number of studies	Studies
Generative (AI)	3	[51] [52] [53]
Blockchain	1	[54]
Chatbot/virtual assistance	1	[55]
Mixed Reality (MR)	1	[56]
Big Data	1	[57]

Learning Analytics (LA)	1	[58]
Game Based virtual Simulators (GVS)	2	[59] [60]
Intelligent Tutoring Systems (ITS)	1	[61]
Machine Learning (ML)	2	[62] [63]
Vector Machine (VM)	1	[64]

TABLE VII. RECAP OF THE INCLUDED STUDIES ACCORDING TO THE MAIN TOPICS

Main topic	Studies	NB
Factors for including AI in online CPD programs topics	[51] [63] [65] [66] [67] [68] [69] [70]	08
Reasons of including AI in online CPD as a scaffolding tool.	[52] [54] [55] [56] [57] [58] [59] [60] [61] [62] [64] [71] [72] [73]	14
Recommendations for the Competency Profile of the “Digital Teacher”.	[53] [74] [75]	03

Teachers approve AI’s capacity to reproduce regular tasks like preparation, evaluation, and feedback, enabling them to focus more on activities that support student learning [78].

However, despite the positive impact of AI on teaching practices, teachers still have the feeling of stress, anxiety and a lack of self-confidence when adopting unfamiliar technologies[79]. CPD programs play a vital role in boosting teachers’ self-confidence and competencies in utilizing AI tools, ultimately fostering a more confident AI-based teaching environment. [63]. Table VIII below, summarizes and describes the main findings of the selected studies related to reasons why AI must be included in CPD programs’ topics.

TABLE VIII. FACTORS FOR INCLUDING AI IN ONLINE CPD PROGRAMS TOPICS

Study/ Country	Research design	Sample/ targeted population	Findings
[51] USA	Literature Review	In-service teachers	<ul style="list-style-type: none"> – ChatGPT and its successors offer personalized learning, advanced writing support, and foster creative thinking for teachers. – Educators must take proactive measures to ensure the ethical and moral use of these tools. – Recommended AI Integration Practices for Teacher Educators.
[65] Nigeria	Quantitative method	79 In-service science teachers	<ul style="list-style-type: none"> – Science teachers approved the integration of AI in the science classroom. – teachers’ self-esteem and the ease of utilization of AI would make science teachers incorporate AI in the classroom and reduce their stress /anxiety levels. – When teachers are trained on the utilization of AI tools, they become more confident to act in AI-driven classroom environment. – All findings above are not influenced by demographic variables of participants (Gender, Age, Localization).
[68] Slovenia	Quantitative method	1215 In-service science teachers	<ul style="list-style-type: none"> – The study findings indicate that continuous professional development plays a crucial role in enhancing science teachers’ preparedness for AI-integrated assessment methods. – Adequate training and support for teachers are essential to help them navigate the challenges and harness the opportunities that AI technology presents in education.
[69] Germany	Qualitative and quantitative methods	12 vocational school-teachers and 746 apprentices	<ul style="list-style-type: none"> – both teachers and apprentices consider basic theoretical concepts of AI a relevant learning content in the additional AI qualification. – However, apprentices exhibit a preference for a teacher-centered approach to gaining additional AI qualification.
[66] China	quantitative method	1013 In-service teachers	<ul style="list-style-type: none"> – Most teachers possess moderate to high level of AI literacy and have the ability to enhance their understanding of AI

			<p>resources used in the classroom.</p> <ul style="list-style-type: none"> – There is a strong correlation between teachers’ educational background and AI literacy. That is, teachers who have more educational background tend to have a better performance at an AI-driven class environment. – Teachers should be placed at the forefront of AI literacy, for fostering the creation of an inclusive society. This initiative is essential for equipping educators with skills needed to effectively integrate AI into their teaching, ensuring its responsible and meaningful use in the future.
[70] South Korea	Systematic Literature Review	134 papers	<ul style="list-style-type: none"> – The 5.0 industry revolutions underscore the urgent need for (i) updated Technical and Vocational Education and Training (TVET) curriculum and modernized labs equipped with AI-supported technologies/functional areas, alongside (ii) comprehensive training for TVET teachers in these technologies to ensure the effective delivery of education and skills training. – It’s essential to recognize that Artificial Intelligence, Big Data, Data Science, Recommender Systems, Nano Technology, Cloud Computing, and IoT are the future building blocks of the TVET curriculum, labs, training delivery, and teacher training. Bridging the gap between AI advancements and educational practices requires collaborative efforts from TVET training providers, policymakers, industry, academia, and researchers.
[67] UK	Exploratory review	141 studies/ In service teachers	<ul style="list-style-type: none"> – Developing a better understanding of artificial intelligence may enhance teachers’ roles as catalysts in designing, visualizing, and orchestrating AI-enabled teaching and learning process.
[63] Slovakia	Literature Review	In service teachers	<ul style="list-style-type: none"> – ICALL(intelligent computer assisted language learning) professional training helps teachers to be updated and informed with the latest AI-based educational tools and provide them with necessary skills to an effective integration of these new technologies in their classrooms. – having an appropriate training for using AI technologies and positive AI-related experience, make teachers feel well prepared and confident to act in AI technology-enhanced environments.

C. Reasons for Including AI in Online CPD as a Scaffolding Tool

Continuous professional development is crucial for teachers to stay updated on new methods, strategies, and technologies. Artificial intelligence has the potential to change traditional teaching approaches, offering more effective tools for classroom instructions and lesson planning, which was discussed in the section above.

Our included studies have unveiled a wide range of tech tools that help trainers establish an intelligent CPD environment tailored to teachers’ needs and pace, improving the quality of learning experiences and professional growth. Generative AI is considered one of the tech tools that is capable of creating novel content without explicit human programming [51] [52] [53].

Block chain technology with its ability of ensuring security and privacy of teachers’ data through tamper-resistant and verifiable transaction records eliminating reliance on central authorities [54].

Mixed reality MR which entails combining elements of Virtual Reality (VR) and Augmented Reality (AR) to offer users a more immersive and interactive learning experience [56] [80].

Applying network big data to teachers' education involves leveraging large-scale datasets related to educational networks, trainer-teachers interactions, and educational resources in order to extract valuable insights and enhance the quality of teaching and learning experiences [57]. Learning analytics emerges as a pivotal tool for collecting, analyzing, and interpreting data related to teachers and their contexts to optimize training strategies, in order to inform decision-making, improve educational outcomes, and enhance the overall learning experience for all stakeholders [58].

Intelligent simulators recreate authentic educational environments similar to the real context of teaching, to practice new skills with intelligent feedback and coaching identical to human expertise [59] [60].

Intelligent tutoring systems (ITS) personalize the learning experience by offering tailored support, feedback, and guidance based on individual needs and learning styles [61], using machine learning [62] [63], and other advanced technologies.

Table IX below, summarize and describe the principal findings of the included studies in this field.

TABLE IX. REASONS FOR INCLUDING AI IN ONLINE CPD AS A SCAFFOLDING TOOL

Study	Research design	Sample/ targeted population	Findings
[52] South Africa	qualitative approach/	In service school teachers	<ul style="list-style-type: none"> Generative language models such as ChatGPT have emerged, enabling teachers to get specific materials and support mechanisms. ChatGPT has enabled teachers to have open access to lesson plans. Generative language models act as tools with the objective of scaffolding teaching and learning with no intention to replace teachers.
[54] Kazakhstan	Experiment	In service teachers	<ul style="list-style-type: none"> Blockchain technologies can bear revolutionary changes for the teaching and learning process, by developing an educational system more inclusive, transparent, and efficient. It offers the capacity to track and validate teacher improvement through a decentralized ledger, leading to a more equitable approach to professional learning. Also, it can be used as a powerful tool to motivate teachers by providing them with tangible, verifiable records of their professional development. Blockchain technologies provide a decentralized and verifiable record system that is tamper-proof and fosters trust, hence, ensuring transparency and integrity in teacher CPD.
[55] Greece	Systematic Literature Review	73 papers	<ul style="list-style-type: none"> Recommending some essential steps to develop a Chatbot or educational conversational agent (ECA): 1st step: the definition of ECA's teaching goals and educational materials, based on information relevant to the course literacy, students' needs and the types of the teaching subjects the ECA should use. 2nd step: the development of the ECA and its functions. 3rd step: the evaluation of efficacy of the developed ECA to avoid any malfunctions or weaknesses.
[71] Chile	Analytic/ quantitative methods	108 In service chemistry teachers	<ul style="list-style-type: none"> The study stresses on the potential of AI as powerful tool for generating audiovisual material, interactive content development, and event logs, particularly in the context of e-learning instructional design (ID) integrating the Educational Computational Chemistry (ECC) and (e-PBL) problem-based leaning.
[56] USA	Systematic Review	In service teachers	<ul style="list-style-type: none"> The Integration of AI and sensor data (visual, auditory, physiological inputs) holds great promise in reducing the cognitive load of the humans needed in the process for use of simulation in teacher education and in minimizing the necessity for multiple simultaneous human meetings. In a learning MR-based environment, AI is needed to enable the software controlling the virtual setting to interpret both verbal and nonverbal interactions, steering character behaviors contextually and providing feedback and coaching similar to human cognitive capabilities.
[57] China	Qualitative and quantitative methods	University teachers	<ul style="list-style-type: none"> The use of network big data analysis helps to evaluate the efficiency of the implementation of teacher training policies in vocational colleges to help teachers improve their professional skills.
[58] China	Systematic Review	30 studies about teachers' education	<ul style="list-style-type: none"> AI and LA have brought some opportunities for teachers in different educational levels, in order to enhance teaching-learning experiences, including evaluation, tracking, adaptive learning. Whereas, ethical concerns related to privacy, data security, bias, and discrimination shouldn't be ignored. the current rate of AI and LA adoption in education lags behind other sectors such as medicine, industry, and finance.
[64] China	Quantitative method	897 university teachers	<ul style="list-style-type: none"> The paper introduces three distinct AI technologies - support vector machine based on immune algorithm, support vector machine based on particle swarm optimization, and pure support vector machine- each designed to enhance the accuracy and efficiency of data prediction and analysis. The study's comparison between predicted and measured data showed compelling results, demonstrating the predictive capabilities of these AI technologies.
[72] China	Analytic method	1834 In service teachers	<ul style="list-style-type: none"> The research proposes a fully automated evaluation approach for detecting cognitive engagement among in-service teachers

			<ul style="list-style-type: none"> within online professional learning community. By using a highly automated method, the study introduces an intelligent supervision system that effectively guides and intervenes in learners' online discourse.
[59] Turkey	Qualitative method/ Experiment	18 teachers	<ul style="list-style-type: none"> Participant teachers have a positive attitude toward the simulation-based training, and they consider it authentic and entertaining. Training-simulation offers participant teachers flexibility and big opportunities to practice new developed skills in an authentic situation wherever and whenever they want, leading to perfectionate their teaching abilities.
[73] Indonesia	Descriptive method	29 In service science teachers	<ul style="list-style-type: none"> Teachers show a positive attitude towards the use of AI in designing higher-order thinking skills (HOTS) based on learning science. AI-based system offers teachers adaptive feedback and instructions for their lesson plans preparation according to a pre-test of knowledge. Participants can arrange an appropriate time and space to take part in online training courses.
[61] Indonesia	Descriptive method	29 In service science teachers	<ul style="list-style-type: none"> Intelligent tutoring system (ITS) has proven its efficacy in helping teachers in online training, especially in the development of lesson plans, by the personalized instructions offered to teachers based on their own backgrounds. Help teachers to solve the problem of absenteeism in the face-to-face training meetings because of schedules of teaching and full day activities.
[62] South Korea	Quantitative	In service teachers	<ul style="list-style-type: none"> Machine learning is an appropriate tool to identify and explore important predictors to teachers' job satisfaction, merging a big number of TALIS variables in one prediction model using MNET technique.
[60] USA	Experiment	102 In service science teachers	<ul style="list-style-type: none"> The use of TeachLive simulator has an effective impact on the participant teachers' targeted skills of the training scenario, leading to improve those teachers' skills in the real teaching situations.

D. Recommendations for the Competency Profile of the “Digital Teacher”.

In this section, our included studies provide some recommendations for the Competency Profile of the “Digital Teacher” in 21-century. These required qualities must be taken into consideration as a framework in the elaboration of

the CPD programs, each country must adapt this framework according to its specific educational system, including context, resources, and needs. The aim of this framework is to prepare teachers capable of using, creating and performing easily and confidently in an AI-based educational environment. Table X shows the recommendations for effective integrating of AI in online CPD.

TABLE X. RECOMMENDATIONS FOR EFFECTIVE INTEGRATING OF AI IN ONLINE CPD

Study	Research design	Sample/ targeted population	Findings
[74] China	Literature Review	In service teachers	<ul style="list-style-type: none"> The study proposes and analyzes DigCompEdu and P21's as frameworks that provide guidelines enabling educators to use tools and plan their own learning programs. It summarizes the necessary digital competencies that teachers must develop to control an AI-driven learning environment. It provides some recommendations for an effective integration of AI to educational fields.
[53] China	Qualitative and quantitative methods	108 University teachers	<ul style="list-style-type: none"> The proposition of an AI Ecological Education Policy Framework to address the multifaceted implications of AI integration in university teaching and learning based on, a pedagogical dimension concentrates on using AI to improve teaching and learning outcomes, a Governance dimension tackles issues related to privacy, security, and accountability, and an operational dimension addresses matters concerning infrastructure and training
[75] Canada	Qualitative method	34 experts from six countries	<ul style="list-style-type: none"> The study recommends a Competency Profile for the Digital Teacher (CPDT) that is required in CPD programs in order to prepare teachers capable of performing effectively in an educational environment supported by AI.

E. *Techno-didactico-pedagogical Framework for Integrating AI in Moroccan CPD programs*

The diagram below (Fig. 4) describes the implementation of our proposed framework including the relationship between technologies adopted to develop an adaptive learning environment, alongside some selected topics related to the development of teachers' AI literacy and the required skills for performing and utilizing AI-based tools to promote the teaching and learning process.

In the quest to enhance the quality of CPD programs in Morocco, an innovative framework is being suggested to adopt in order to set up an intelligent platform. This platform is designed to deliver adaptive Professional training by gauging teachers' initial level and comprehending their preferences and learning styles. The operation of this intelligent platform is based on machine learning (ML) technology. This (ML) technology contains big databases stored in a cloud computing system, protected by a blockchain technology to secure personal data, and create a private environment. This bigdata is explored by learning analytics system using a Support Vector Machine (SVM) algorithm, the aim of which is to profile teachers and provide a personalized learning path based on every teacher's profile through the utilization of generative AI technology capable of generating adaptive content, assessments, simulations using Mixed reality technology, and adaptive support using Intelligent tutoring system ITS. The ITS provides interactive conversational agents such as chatbots, and automated feedback mechanisms, using natural language processing (NLP) technology to understand and analyze the inputs of teachers. This combination of technologies aims to provide adaptive content in the topics proposed in the framework above, or in any other topics according to CPD training goals or teachers' needs.

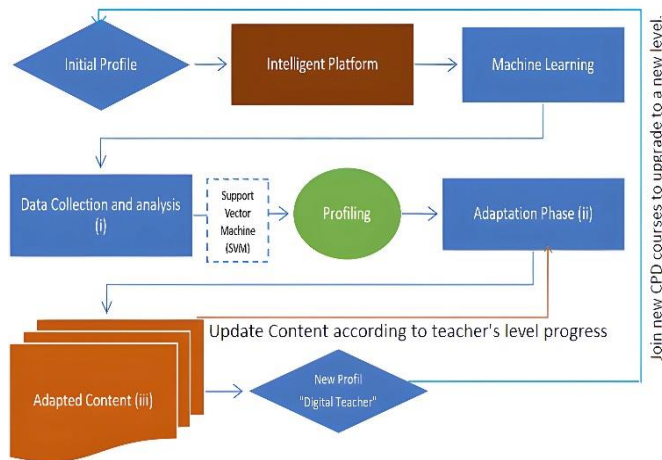


Fig. 4. The proposed framework diagram.

The limitations of this suggested AI-driven framework remain unclear as it is currently being implemented and has yet to be fully explored. In our forthcoming study, we will elucidate both the strengths and weaknesses of this framework. Table XI shows the data collection and analysis phase.

TABLE XI. THE DATA COLLECTION AND ANALYSIS PHASE (I)

<p>Cloud Computing Enables the platform to scale efficiently to accommodate a large number of users. Ensures accessibility from various devices, facilitating anytime, anywhere learning.</p>	<p>Provide data</p>	<p>Big Data analytics Analyzing large datasets generated by teachers helps in gaining insights into their behavior, preferences, and learning patterns, in order to improve content, identify trends, and enhance the overall learning.</p>
<p>All data is secured using Blockchain technology</p>		
<p>Security and Privacy Collect and store teachers' personal data in a secure, transparent, and tamper-resistant way</p>		

PHASE (III). DEVELOPMENT OF TEACHERS' AI LITERACY TOPICS

Introduction to Artificial Intelligence

- Understanding the basics of AI, machine learning, and deep learning.
- Exploring the significance of AI in education.

AI Tools for Classroom Management

- Integrating AI tools to streamline administrative tasks.
- Using AI for attendance tracking, grading, and scheduling.

Adaptive Learning Systems

- Implementing adaptive learning platforms that personalize content based on individual student needs.
- Analyzing student data to inform instructional decisions. Table XII shows the adaptation phase.

Chatbots and Virtual Assistants

- Utilizing AI-powered chatbots for student support and communication.
- Creating virtual assistants to provide instant feedback and answer common queries.

Data Analytics and Learning Insights

- Understanding the role of data analytics in educational settings.
- Using learning analytics to assess student performance and make data-driven decisions.

AI in Content Creation and Assessment

- Leveraging AI for generating customized learning materials.
- Exploring automated assessment tools and feedback systems.

Digital Literacy and Responsible AI Use

- Reinforcing digital literacy skills among students.
- Addressing ethical considerations and responsible use of AI in the classroom.

Gamification and AI

- Integrating gamification elements to enhance engagement.
- Exploring AI-driven game-based learning experiences.

Mixed Reality (MR) in Education

- Incorporating AR and VR technologies for immersive learning.
- Designing virtual labs and simulations using AI.

AI for Differentiated Instruction

- Tailoring instruction to meet diverse learning needs using AI.
- Implementing strategies for inclusive learning environments.

Collaborative Learning Platforms

- Integrating AI into collaborative tools for group projects.
- Facilitating virtual teamwork and communication.

Privacy and Security in AI Education

- Understanding the importance of data privacy in AI applications.

the work of Cecilia Ka Yuk Chan in 2023 [53], we have adopted the three key dimensions -Governmental, operational, pedagogical- according to the Moroccan context, including:

1) Governmental dimension (Ministry of education).

a) *Policy and regulation:* Governments play a crucial role in formulating policies and regulations that guide the integration of AI in education. This includes setting ethical standards, ensuring data privacy, and establishing frameworks for responsible AI use in the educational sector.

b) *Funding and investment:* Governments may allocate resources and funding to support AI initiatives in education. This can involve investments in research, development of AI technologies, and providing financial incentives for educational institutions to adopt AI-driven solutions.

c) *Inclusion and equity:* Governments should focus on ensuring that the benefits of AI in education are accessible to all students, regardless of socio-economic background or geographic location. This involves addressing issues of digital divide and promoting inclusivity in AI-driven educational initiatives.

d) *Monitoring and evaluation:* Governments can establish mechanisms to monitor and evaluate the impact of AI on education. This includes assessing the effectiveness of AI applications, ensuring equity in access, and addressing any potential biases or ethical concerns.

e) *Collaboration and partnerships:* Facilitating collaboration between government agencies, educational institutions, industry stakeholders, and research organizations is vital. Governments can encourage partnerships that promote the responsible and effective use of AI in education.

2) Operational dimension (Teachers, trainers).

a) *Teacher training:* Training educators and providing professional development opportunities are crucial components of AI integration in education. Governments can facilitate training programs to ensure that teachers are well-prepared to incorporate AI technologies into their teaching methodologies.

b) *Infrastructure and connectivity:* Ensuring adequate infrastructure and connectivity is essential for the successful implementation of AI in education. Governments may invest in improving digital infrastructure, providing internet access, and ensuring that schools and educational institutions have the necessary technology equipment and resources.

c) *Coding and programming skills:* Encourage teachers to learn coding languages commonly used in AI development, such as Python. Many online platforms offer interactive tutorials and coding exercises suitable for beginners.

d) *AI-related clubs and extracurricular activities:* Establish AI clubs or extracurricular activities where teachers can explore AI topics, collaborate on projects, and share their knowledge with peers.

e) *AI-related competitions:* Encourage participation in AI-related competitions or hackathons. These events provide teachers with practical experience, foster problem-solving skills, and promote collaboration.

TABLE XII. THE ADAPTATION PHASE (II)

Generative AI	Personalized Learning Paths	Adaptive Content Generation includes custom quizzes, interactive simulations, and supplementary resources tailored to individual learning styles. Identifying trends, predicting potential learning challenges, and recommending improvements to the learning platform.	
		Adaptive Assessments creating adaptive assessments that adjust difficulty based on a teachers' performance, ensuring that each teacher appropriately challenged.	
	Intelligent tutoring systems (ITS) offering tailored support, feedback, and guidance based on individual needs of teachers	Natural Language Processing (NLP) language understanding, language generation, machine translation, sentiment analysis	Interactive Conversational Agents (Chatbots) virtual assistants that engage with learners in natural language, answering queries, providing explanations, and offering real-time assistance in order to create an interactive and responsive learning environment.
Mixed Reality MR	Immersive Learning Experiences Creating realistic simulations, 3D classrooms, or virtual labs, allowing teachers to experiment, teach, and learn in a risk-free environment. Game-Based Learning Applying game mechanics and elements to educational content can enhance engagement and motivation. Gamification techniques can be integrated to make learning more interactive and enjoyable.		

F. Recommendations

To have a successful integration of AI in the Moroccan educational sector, many dimensions must be combined in order to foster innovation and prepare teachers and students for the demand of the digital age. Drawing inspiration from

3) Pedagogical dimension (Students)

a) *Curriculum development*: One of the most important pillar to have a successful integration of AI is updating curricula to include relevant AI topics. This may involve introducing AI courses, workshops, and educational programs to equip students with the necessary skills for the digital age.

b) *Interactive games and simulations*: Use interactive simulations and educational games that illustrate AI concepts in a visually engaging manner. This approach can make learning more enjoyable and accessible.

c) *Interactive AI tools*: Introduce students to user-friendly AI tools and platforms designed for educational purposes. These tools can help students experiment with AI concepts without requiring advanced technical knowledge.

V. STUDY LIMITATIONS

- A prevalent focus on found studies has been on pre-service teachers undergoing initial training or professional qualification. Whereas our study focuses only on in-service teachers engaged in online continuing Professional Development (CPD).
- While numerous studies have delved into online CPD, a significant gap exists in the integration of AI specifically within the context of teachers' online CPD. While Some of those studies tackled only the use of ICT in general.
- Due to the limited accessibility of many studies, our research focuses exclusively on open access sources to avoid potential biases from restricted access to paid articles.
- Many studies delve into the integration of AI in the educational fields in general with no focus on teachers' online CPD.

VI. CONCLUSIONS AND FUTURE RESEARCH

After analyzing the included studies, it becomes evident that AI holds a positive impact for revolutionizing education at large, with a particular emphasis on enhancing teachers' online CPD. The integration of AI can offer a large bunch of diverse intelligent tools that can be used to foster self-development and facilitate the learning and teaching process. However, the successful integration of AI into teachers' personal and professional life requires a complementarity of governmental, operational, and pedagogical dimensions, alongside technological-didactical-pedagogical engineering to create an innovative intelligent environment that empowers teachers to develop new skills and abilities, resulting in the renovation of pedagogical transformation that ultimately benefits student outcomes.

The findings of our research will be implemented in real-life settings in partnership with Morocco's ministry of education. We plan to evaluate the effectiveness of the proposed framework for Continuing Professional Development (CPD) programs by testing it on a cohort of teachers. Consequently, the insights and results gathered from this practical application will be discussed in detail in a forthcoming study.

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