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Advancing AI education: Assessing Kenyan in-service teachers' preparedness for integrating artificial intelligence in competence-based curriculum

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ABSTRACT

With the advancement of technology, emerging technologies like Artificial Intelligence (AI) have also been growing rapidly and becoming more common than ever before. Kenya has taken tremendous steps in adopting the use of emerging technology in different sectors of the economy. In realization of the need to have a skilled digital workforce to develop solutions using these emerging technologies, Kenya has undertaken curriculum reforms and introduced the Competency-Based Curriculum (CBC) which has included digital literacy and coding in elementary school. Furthermore, computer science has been introduced in Junior Secondary School. In view of these changes, teachers should be adequately prepared with knowledge, skills, and attitudes to effectively teach these new technologies. However, in Kenya, AI was not and still is not part of the teacher training curriculum. Additionally, there are inadequate professional development opportunities in AI for both pre-service and in-service teachers since AI is not part of the CBC curriculum. That notwithstanding, it is inevitable for teachers in the current world to introduce AI to learners. Therefore, this study's objectives were to assess the confidence in AI, attitudes toward AI, AI ethics, subjective norms, perceived threats, and the readiness to teach AI among Kenyan K-12 in-service teachers and to assess how these factors influence their readiness to teach AI. To achieve these objectives, this study employed a quantitative research methodology by administering a survey using Google Forms to a random sample of 308 teachers from different grades from 37 out of 47 counties in Kenya. The findings showed that confidence in AI, AI ethics and subjective norms significantly influenced AI readiness while attitude towards AI and perceived threats did not significantly influence AI readiness. These results are significant in providing a basis for education policy change on AI education in Kenya, such as transforming the teacher training curriculum to include AI and designing AI professional development programs for in-service teachers to ensure they are well-equipped to teach AI.

1. Introduction

Teachers in any society play a critical role in the teaching and learning processes especially when introducing new topics in the curriculum (Sanusi, 2023). In Kenya, teachers have been championing the implementation of Competency-Based Curriculum (CBC), which was introduced through a curriculum reform and has been in effect since 2017. This reform was driven by the necessity to equip students with competencies that are in line with the evolving demands of the 21st century skills (Akala, 2021). CBC was aimed at equipping every learner in seven core competence areas: communication and collaboration, critical thinking and problem-solving; citizenship; learning to learn; self-efficacy; and digital literacy (KICD, 2017).

The digital literacy component included coding with Scratch (Scratch Foundation, 2022) as an introduction to computer science for learners to nurture creativity and computational thinking skills. Through the Digital Literacy Program (DLP), the Government of Kenya issued over one million learner and teacher Microsoft Windows devices

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to public primary schools across the country (ICTA, 2023) to support the integration of technology in teaching and learning in the basic education system. For the successful implementation of the coding curriculum, the Teachers Service Commission (TSC) and non-governmental programs have been retooling teachers to improve their digital literacy skills to enable effective use of the devices in teaching and learning (Kerkhoff & Makubuya, 2021) as well as teaching coding with Scratch.

While the introduction of coding was a timely intervention to address the gap identified by Cambridge University (2023), AI remains not a part of the Kenyan curriculum. Since AI is rapidly revolutionising every sector and becoming increasingly integrated into our daily lives, Integrating AI into the k-12 curriculum would be an important component of advancing AI education (Lee & Perret, 2022). AI integration would be important as it would help the learners start learning the basics of AI from the early years of education which would ensure they become responsible users and developers of AI products (Sabuncuoğlu, 2020; Anne et al., 2023). Further, it would empower students to develop valuable skills that would enable them to adapt to the demands of a rapidly changing society, therefore thriving in the inevitably AI-driven future.

Tools such as Scratch, used in the digital literacy in CBC, can be useful to introduce AI to learners of any grade. This can be done by using different extensions such as Tooee to introduce big data and AI education to K-12 students (Park & Shin, 2021) as well as AI for secondary school and even undergraduate students (Estevez, Garate, & Graña, 2019). Therefore, with the current tools in the current curriculum, AI can easily be integrated.

The responsibility to introduce such new ideas to learners, still largely lies with the teachers (Oyelere et al., 2022). However, teachers in Kenya face a significant challenge in adequately introducing the learners to AI since it was not part of their curriculum when they embarked on their teaching careers (Lindner & Berges, 2020). Further, the levels of Information Communication Technologies (ICTs) education that they receive during training is insufficient to prepare them to follow new and rapidly advancing technologies (Cambridge University, 2023). Additionally, AI has not been made part of the curriculum because developing a curriculum that meaningfully introduces AI content to K-12 students is challenging and the support and tools for the development of these curriculums are limited (Anne et al., 2023; Zhou et al., 2020) more so in developing countries such as Kenya. With AI not being part of the curriculum there have been limited professional development programs on AI resulting in many teachers being ill-equipped to teach AI. This demonstrates the urgent need for the development of an AI Curriculum in Kenya and a comprehensive training and professional development program that can empower educators with the knowledge, skills and attitudes required to effectively teach AI-related topics either in cross-curricular or as a standalone subject.

To our knowledge, initiatives on how teachers in Kenya regard the integration of AI into the school system have not been explored. However, there have been few recent similar studies in Africa which investigated the teachers' readiness and intention to teach AI in Nigeria and Namibia schools (Ayanwale et al., 2022; Jatileni et al., 2023). To this end, this study attempts to understand how prepared K-12 in-service teachers are to teach AI. Therefore, this study investigates Kenyan K-12 in-service teachers' confidence in AI, attitudes toward AI, AI ethics, subjective norms, perceived threats, and their readiness to teach AI. Additionally, we determine how the confidence in AI, attitudes toward AI, AI ethics, subjective norms, and perceived threats among Kenyan K-12 in-service teachers influence their readiness to teach AI.

Based on the highlighted aims, the following research questions guided our study.

1. What is the level of confidence in AI, attitudes toward AI, AI ethics, subjective norms, perceived threats, and readiness to teach AI among Kenyan K-12 in-service teachers?
2. Do the confidence in AI, attitudes toward AI, AI ethics, subjective norms, and perceived threats of Kenyan K-12 in-service teachers influence their readiness to teach AI?

The First section of this paper has been the introduction which provided the background of the study and the importance of carrying out the study. The second section provides a literature review, which establishes the context for our study by examining the current state of AI teaching in K-12 schools, with a particular focus on Africa. The third section outlines the development of five hypotheses that will be tested in this research. The fourth section explains the methodology employed in the study, including the selection of participants, the data collection instrument, the procedure for data collection, and the analysis process. The fifth section presents the results of the quantitative data analysis. The sixth section offers discussions and implications based on the findings, along with the study's limitations and suggestions for future research directions. Finally, the paper concludes with a summary of the main points.

2. Literature review

Education is the key driver of the world's social, human rights, and economic sectors. In Kenya, the education sector still struggles with many challenges, such as inadequate infrastructure, a lack of enough resources, high dropout rates, and mismatches between learned theory and skills outside classrooms (Kibuku et al., 2020; Akala, 2021). That notwithstanding, Kenya has been making steps in implementing digital literacy programs for elementary schools due to the need for digital skills for the 21st century. As AI advances rapidly and more AI products are being developed every day, a larger part of the population is only consumers of these AI products but has very limited knowledge of how they are developed (Ma et al., 2023; Sanusi et al., 2023). This has pushed educators and policymakers to recognize the increasing need to prepare the next generation for a future largely shaped by AI technologies, therefore championing the integration of AI curriculums in K-12 schools over the last few years in different parts of the world.

2.1. Artificial intelligence in K-12 education

With the rapid advancement of AI, there has been growing interest from across the globe to introduce AI in the K-12 curriculum. There have been research studies from different parts of the world that have looked at the inclusion of AI in the K-12 curriculum. A study by Anne et al. (2023) investigated the everyday experiences and ideas of students in grades 4 and 5 about AI to inform possible entry points for learning. They proposed the ethics of AI and students' conceptions of AI as key themes that should be considered for the co-designing of AI curricula. Norouzi et al. (2020) designed an intense one-month-long curriculum to teach Machine Learning and Natural Language Processing. It was aimed at providing high school students with a more in-depth understanding of AI and the tasks that AI can be used for. The study found that a combination of objectivist and constructivist approaches was successful in introducing AI. Additionally, they found that introducing basic programming concepts in the AI curriculum is an essential building block.

Van Brummelen and Lin (2020) adopts a Value-Sensitive Design approach to explore how teachers' values influence the design of AI curricula and tools while incorporating AI into the core curriculum. Co-design workshops involving 15 K-12 teachers and researchers were conducted to collaboratively create lesson plans integrating AI tools and AI concepts into various subjects. The study identified the need for additional support for teachers in AI tools and curriculum, especially in addressing ethics, data discussions, learner evaluation, engagement, peer collaboration, and critical reflection. It also presents an illustrative lesson plan for teaching AI in non-computing subjects and discusses the challenges and benefits of remote co-design with K-12 teachers. Another study by Sanusi et al. (2022) explored teachers' preconceptions of

teaching machine learning in high school by describing the initial conception of teaching machine learning by 12 African in-service teachers. The study used semi-structured questionnaires, recruiting 12 high school (grades 10–12) teachers from African schools. The five categories used on semi-structured questionnaires were supporting student technical knowledge, knowing the concept, personal professional development, contextualising resources and tools, and sustainability for developing goals. The findings were that there is a need to train in-service teachers to use existing tools designed for AI and that teachers should be involved in developing the curriculum.

Wang & Cheng (2021) in Hong Kong investigated the barriers to K-12 schools incorporating AI in education to highlight the necessity of embracing AI in education as a wide range, given the understanding of the collective notion. The study identified three key directions of AI in education, i.e., learning with AI, learning about AI, and learning from AI through a case study that examined the perceived barriers to implementation. The study argues that there is a continued need to know the link between barriers and prioritize school efforts to reduce them with high linkage. Ayanwale et al. (2022) provide insight into the factors affecting Nigerian in-service teachers' behavioural intention and readiness in teaching AI in their study that investigated teachers' readiness and intention to teach artificial intelligence in schools. The study found that confidence in teaching AI predicts the intentions. Additionally, AI relevance was also shown to predict the readiness to teach. However, AI Anxiety and the social good of AI did not have a direct impact on the teachers' readiness to teach AI. Sanusi and Olaleye (2022) while looking to understand how students' cultural competence and ethics combined to influence AI content, found that Cultural competence and ethics have high impacts on AI content. The study also found that the association between AI ethics and AI content has high predictive values that show the importance of ethics in AI learning. The study recommends that stakeholders and educators emphasise the humanistic approach, cultural elements, and ethical considerations in designing AI content. These research findings highlight the significant impact that comprehensive AI programs in K-12 education can have on enhancing AI literacy among children, thereby equipping them with the skills necessary to excel in the 21st century.

2.2. Teaching artificial intelligence in Kenyan schools

Currently, in Kenya, AI is being taught at tertiary institutions but very little has happened in the K-12 to integrate AI. Over the last few years, there has been an increased interest in incorporating AI literacy into the k-12 curriculum. This has led to non-governmental and private institutions such as iLab (2023) organising children's AI boot camps.

However, in formal school programs, it remains a challenge to make space for a new K-12 AI curriculum due to tight school schedules with current curriculums (Zhou et al., 2020). Additionally, there have been barriers to implementing AI literacy in K-12 schools such as a lack of teachers' AI knowledge, skills, and confidence, a lack of curriculum design and a lack of teaching guidelines (Sanusi et al., 2022). Nevertheless, there has been tremendous progress from across the world to standardise what AI concepts students should learn at various levels in countries like China, the United Kingdom, Thailand, Korea, and the European Union (Su & Zhong, 2022). While these developments are happening across the world, Kenya has only introduced coding in its curriculum and is still yet to incorporate AI education into the curriculum. Kenya, as a technology hub in East Africa, AI has only been used to provide personalised education for learners with tools such as SOMANASI (Global Grand Challenges, 2023).

These studies demonstrate the growing importance and development of AI education in K-12 and the need for comprehensive AI training and professional development programs for educators to effectively teach AI. At the time of this study, there has been no literature on any implementation of an AI curriculum for k-12 in Kenya demonstrating the need for more research on how to effectively implement AI in Kenyan schools.

3. Hypotheses development

3.1. Confidence in AI

Confidence can be defined as individuals' belief in their abilities to successfully carry out or execute a desired behaviour (Ayanwale et al., 2022). Confidence has been highlighted as an important factor affecting an individual's readiness. The greater the confidence regarding one's ability, the more likely one is to perceive being prepared and ready for relevant learning or work opportunities (Dai et al., 2020; Komarraju et al., 2013). Additionally, Chai et al. (2020) found that students' confidence significantly influences students' readiness to learn and use AI. To validate existing results, this study explored the relationship between teachers' confidence in learning AI and readiness. Thus, this study proposed the hypothesis below.

H1. Confidence in learning AI significantly predicts teachers' readiness to teach AI.

3.2. Attitude toward AI

Attitude is defined as the way an individual think and feels about somebody/something (Cambridge University, 2023). In the context of this study, we explore the relationship between teachers' attitudes toward AI and their readiness to teach AI in schools. Therefore, we define attitude as the way the teachers think and feel towards AI. According to Schepman and Rodway (2020), the general attitudes of individuals towards AI are likely to influence their acceptance and use of AI. Lichtenthaler (2020), found that companies experienced difficulties implementing AI in their business processes due to negative attitudes among their employees. Scott et al. (2021) also found that medical stakeholders who had positive attitudes toward AI had adopted medical AI applications for diagnosis and disease screening, and stakeholders who had a negative attitude towards AI were hesitant to adopt the use of AI. Additionally, Polak et al. (2022) found that teachers who have a positive attitude towards AI education have a high motivation to introduce AI-related content at school. To validate these findings, this study explores the relationship between teachers' attitudes towards AI and their readiness to teach AI. Hence, the following hypothesis is proposed.

H2. Attitude significantly predicts teachers' readiness to teach AI.

3.3. AI ethics

Tadeo and Floridi (2018) define AI ethics as the moral principles and guidelines governing the development, deployment, and use of artificial intelligence (AI) systems. AI ethics addresses transparency, accountability, fairness, and societal well-being (Zicari et al., 2021) as well as privacy protection and bias mitigation to ensure that AI technologies are developed and utilised ethically and responsibly (Hermansyah et al., 2023). Previous studies (Chiu & Chai, 2020; Chiu et al., 2022) show that the AI curriculum co-creation process enhanced teachers' AI ethics knowledge which fostered confidence to teach AI in class. Borenstein and Howard (2020) also emphasized the importance of ethical considerations in curriculum development for teachers as it significantly influences teachers' readiness to teach AI. These studies indicate the pivotal role of AI ethics on teachers' preparedness to teach. These studies highlight the crucial role of AI ethics in shaping teachers' preparedness to teach AI. To further explore this relationship, this study explored the relationship between AI ethics and teachers' readiness and thus proposed the hypothesis below.

H3. AI ethics significantly predicts teachers' readiness to teach AI.

3.4. Perceived threats of AI

The concept of Perceived Threats of AI refers to an individual's perception of the potential threat or harm caused by the application and or use of artificial intelligence technology (Li, 2023). According to Li (2023), the perceived threat of artificial intelligence is a significant factor in employee turnover intention in luxury hotels. Additionally, Balakrishnan et al. (2021) note that perceived threat is a major factor that can lead to resistance towards the adoption of AI voice assistants as users may feel uncertain about the AI technology which can increase the perceived threat. Further, the threat perception caused by AI can hurt employees' work results and attitudes (Yu et al., 2023). Based on the findings of these studies, this study proposes that, in school settings understanding and addressing perceived threats of AI is crucial for the successful integration of AI in education and teachers' readiness to teach AI and thus proposes the hypothesis below.

H4. Perceived threats significantly predict teachers' readiness to teach AI.

3.5. Subjective norms

Subjective norms refer to an individual's perceptions regarding whether others think they ought to or should refrain from engaging in a specific behaviour (Kimaiyo, 2016). In school environments, teachers 'actions may be affected by the opinions of other people such as the administrators or even their colleagues. The Theory of Planned Behaviour (TPB) outlines subjective norms as one of the components that determine behaviour intention and predicts that it is likely for an individual to perform a behaviour if the subjective norms are favourable (Hassanein et al., 2021). Previous studies (Garcia & Oducado, 2021; Sadaf & Gezer, 2020; Sugar et al., 2004; Wang & Tsai, 2022) have demonstrated that subjective norms influence the degree to which teachers engage in preparedness behaviour and intention to use technology. Additionally, a study by Li (2023) found that perceived organisational support and the perceived value of artificial intelligence can mitigate the negative effects of perceived threats. In education settings, Darling-Hammond (2006) indicates that subjective norms within the educational community can significantly influence teachers' readiness to adopt new technologies. It is therefore expected that the subjective norms of in-service teachers will predict their preparedness to teach AI. To validate these findings and arguments, this study explored the relationship between subjective norms and teachers' preparedness and thus proposed the hypothesis below.

H5. Subjective norms significantly predict teachers' readiness to teach AI.

4. Methodology

This study was conducted in Kenya with in-service teachers across elementary and high school levels. Using a quantitative approach, we gathered the perspectives of 308 in-service teachers from 38 out of 47 counties in Kenya to understand their readiness for AI implementation in Kenyan schools.

4.1. Participants

The respondents of the survey were in-service K-12 school teachers from 37 out of 47 counties of Kenya. Table 1 below shows the demographics of the participants. Our sample comprised teachers from across different grades and teaching subjects in primary and secondary levels. We had more male participants representing 54.9% of the population. Only 2.9% of the teachers were between 18 and 24 years. This low number is attributed to, the majority of the people within this range are still in school or have not acquired a teaching placement by the Teachers Service Commission. While we had respondents from both primary and secondary schools, the primary school teachers were more at 58.4% (see Table 1).

4.2. Research instrument

The instrument that we used in this study was adapted from existing works. Specifically, items on AI readiness and AI ethics were adapted from Wang et al. (2023). Perceived threats from AI items were adopted from Mirbabaie, Brünker, & Möllmann Frick (2022). Items on attitude toward AI, confidence in learning AI and AI relevance were adopted from Ayanwale et al. (2022). Interest in AI was measured with items adapted from the study of Mason & Rich (2020)and the subjective norm items were adapted from Chai et al. (2021). The tool Included a six-point Likert scale that has been proven to be optimal for achieving good reliability and validity of the data collected (Taherdoost, 2019). See the Appendix for the complete instrument including the items used to measure specific constructs.

4.3. Data collection procedure

The survey questions were developed on Google Forms (*Google Forms*, 2008) which were administered online for a period of 4 weeks. With a limited budget, Google Forms were ideal for the study because they are cost-effective and accessible (Amol, 2017). They also provide a user-friendly interface which allows for easy participation and filling of the data by teachers which could have been proven to increase response rates (Amol, 2017). It also allowed for real-time data collection and automated organization (Qizi & Ugli, 2022) reducing the time used in the analysis (Ayanwale et al., 2022).

Before administering the survey, the data collection tool was tested to identify any errors and ensure its reliability as well as estimate how much time it would take a respondent to answer the question (Marshall, 2005). Through this pilot test, it was determined that the items in the data collection tool were appropriate and would take on average about 10 min to fill in the survey. The Universal Resource Locator (URL) to the form was shortened using a URL shortening service and a link management platform bit.ly (Bitly, 2008) to enable tracking and analytics of how far the survey had gone and to help the users easily click on it. The survey was administered in two forms namely a) during in-person training with teachers and b) shared on teachers' WhatsApp groups. During in-person training, we conducted a 45-min introduction session on AI while on the links shared on WhatsApp, there were embedded materials in the introduction that we encouraged the respondents to have a look at to familiarise themselves with AI.

4.4. Data analysis

The collected data was initially checked for completeness, prepared for analysis and descriptive analysis done using R-Instat version 0.7.6. R-

Table 1
Demographic profile of the participants.

		Frequency	Percentages
Gender	Male	169	54.9
	Female	137	44.5
	Prefer not to say	2	0.6
Age	18–24 Years	9	2.9
	25–29 Years	62	20.1
	30–34 Years	67	21.8
	35–39 Years	63	20.5
	40–44 Years	40	13.0
	45–49 Years	26	8.4
	50–55 Years	32	10.4
	Above 55	9	2.9
School level	Primary School	180	58.4
	Secondary School	107	34.7
	Other	21	6.8

Instat is an open-source, free software based on the increasingly used statistics software R (Fundi et al., 2017). The data preparation included appropriately renaming the variables, removing the data used to test the data collection tool, coding the six-item Likert responses, and conducting descriptive statistics for each variable.

We then carried out descriptive analysis of the data to determine the teachers' level of confidence in AI, attitudes toward AI, AI ethics, subjective norms, perceived threats, and their readiness to teach AI. Further, Partial Least Squares Structural Equation Modelling (PLS-SEM) (Byrne, 2010) was employed using SmartPLS 4 (Ringle et al., 2022). This involved the exogenous variables (confidence in AI, interest in AI, AI Ethics, subjective norms, and perceived threats) and endogenous variable (AI Readiness) to test the hypothesised model below in Fig. 1.

We followed the data analysis process as described by Dash and Paul (2021) as follows: a). definition of constructs, b) preparing for Confirmatory Factor analysis (CFA) by drawing variables against the factors in a path diagram, c) running Confirmatory Factor Analysis (CFA) to test for model reliability and validity, d) carrying out the structural modelling to test the structural relationships and e) making conclusions based on the findings.

5. Results

This section presents the results of this study. We focus on the descriptive analyses conducted which showed the teachers' level of confidence, attitude towards AI, their understanding of AI ethics, subjective norms and perceived threats. We also focused on the measurement model assessment, which demonstrates the reliability and validity of the items. Additionally, we highlight the structural model assessment which demonstrates the relationship between exogenous and endogenous variables.

5.1. Descriptive statistics

The descriptive statistics as shown in Table 2 indicates that the teachers are moderately confident in AI and had positive attitudes towards AI. Additionally, there was little variability demonstrating that the teachers' levels of confidence and their attitudes were very similar. The teachers demonstrated a moderate agreement with the ethical aspects of AI but with a higher variability compared confidence and attitude.

The statistics also suggest moderate agreement with the subjective norms, with some variability among respondents. This could be driven by the locations of the participants as well as the nature of the schools they teach since some places like urban centre AI have already been perceived as a good addition of technology tools.

The respondents demonstrated some level of threat from AI with a considerable variability in these perceptions. This is related to the subjective norms because, when the people around educators perceive AI as a threat, especially their seniors, the teachers will also be influenced to perceive AI as a threat.

Finally, teachers demonstrated a moderate readiness to teach AI with some variability. This suggests that, while teachers are getting used to the emerging technologies such as AI, there is still a varying ability in readiness to teach it in schools.

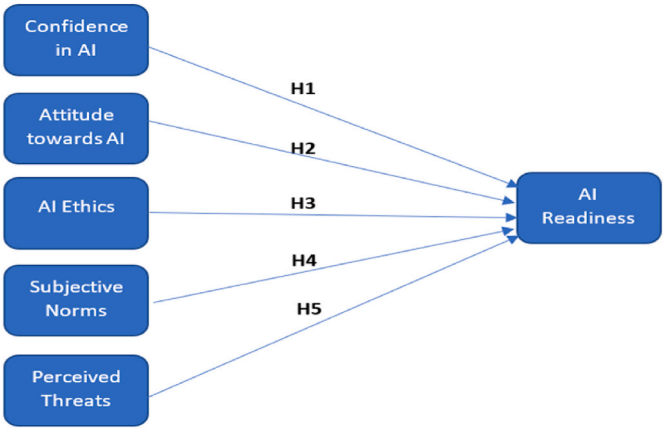

Fig. 1. Proposed research model.

Table 2
Descriptive statistics of the factors.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. deviation
Confidence in AI	308	2	6	4.76	0.80
Attitude towards AI	308	1	6	5.11	0.81
AI Ethics	308	1	6	4.23	1.28
Subjective Norms	308	1	6	4.16	1.16
Perceived Threats	308	1	6	3.68	1.39
AI Readiness	308	1	6	4.14	1.21

Note: 1– Strongly Disagree, 2– Disagree, 3 – Slightly Disagree, 4 – Slightly Agree, 5 – Agree, 6 – Strongly Agree.

5.2. Measurement model assessment

Through the CFA, the measurement model was tested for reliability and validity. This process included 30 items. 6 items were removed due to their factor loadings falling below the threshold of ≥0.708 (Hair Jr et al., 2021) and the measurement model in Fig. 2 ended up with 24 items. These the 6 items were removed from confidence in AI (*conf_q3 (0.594), conf_q4(0.543), conf_q5(0.498)*, perceived threats(*pthr_q3 (0.668)*), AI readiness (*read_q6 (0.68)*) and subjective norms (*snorm_q5 (0.555)* as shown below:

conf_q3(0.594)- I am certain that I can learn the basic concepts of AI.

conf_q4(0.543)- I am certain that I can understand the most difficult AI resources.

conf_q5(0.498)- I am confident that I can succeed if I work hard enough in learning AI.

pthr_q3(0.668)- Students' overreliance on the learning guidance provided by AI technologies may undermine the relationship between teachers and students.

read_q6 (0.68)- I foresee the opportunities and challenges AI technologies entail for education.

snorm_q5 (0.555)- Learning AI can respond to future social changes.

With each construct achieving the benchmarks for Cronbach's alpha (≥0.70), Composite reliability (≥0.70) and Average variance extracted (AVE) (≥0.50) (Hair Jr et al., 2021), the convergent validity was established as shown in Table 3.

Discriminant validity is crucial in guaranteeing the distinctiveness of each variable and their lack of supposed interrelatedness (Chin, 2010). We applied the Heterotrait-monotrait (HTMT) ratio of correlation to measure the discriminant validity. Table 4 presents the results of discriminant validity, demonstrating that each variable was statistically distinct and represented a unique phenomenon within the PLS model, not overlapping with other variables (Franke & Sarstedt, ; Marko et al., 2020) since the construct had a cut-off value of less than 0.85 for Heterotrait-monotrait ratios (Franke & Sarstedt,) (see Table 4).

5.3. Structural model assessment

In Table 5, the direct relationship between exogenous and endogenous variables was examined. Additionally, the hypothesised relationship between the variables was also examined: (H1); Confidence in AI - > AI Readiness ($\beta = 0.385$, p-value 0.000, $f^2 = 0.304$) (H2), Attitude towards AI - > AI Readiness ($\beta = -0.004$, p-value 0.952, $f^2 = 0.000$) (H3), AI Ethics - > AI Readiness ($\beta = 0.473$, P-value 0.000, $f^2 = 0.411$)

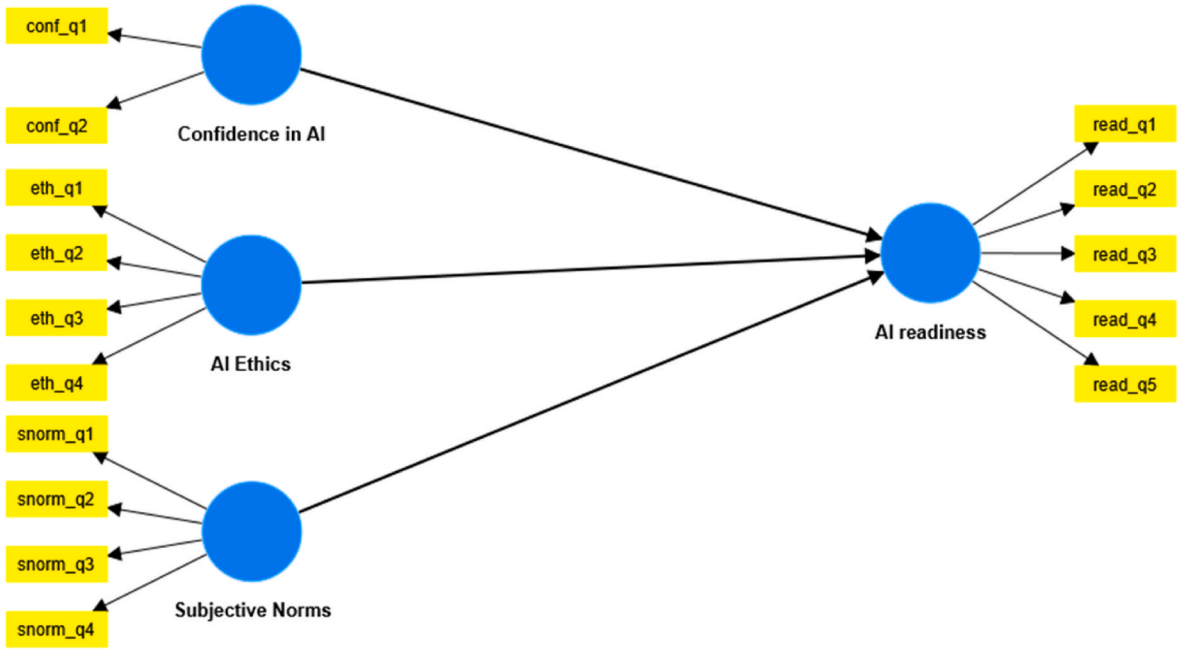

Fig. 2. Supported Construct Model/Structural model.

Table 3
Reliability and convergent validity analysis.

Items	Item loading	Cronbach's alpha	rho_a	Composite reliability	Average variance extracted (AVE)
Attitude towards AI		0.927	0.933	0.948	0.820
att_q1	0.886				
att_q2	0.911				
att_q3	0.941				
att_q4	0.884				
Confidence in AI		0.835	0.844	0.923	0.858
conf_q1	0.916				
conf_q2	0.936				
Ethics in AI		0.914	0.915	0.940	0.795
eth_q1	0.875				
eth_q2	0.928				
eth_q3	0.891				
eth_q4	0.872				
Perceived Threats		0.844	0.873	0.892	0.673
pthr_q1	0.773				
pthr_q2	0.823				
pthr_q4	0.825				
pthr_q5	0.860				
AI readiness		0.939	0.940	0.954	0.804
read_q1	0.897				
read_q2	0.903				
read_q3	0.923				
read_q4	0.873				
read_q5	0.886				
Subjective Norms		0.878	0.884	0.917	0.733
snorm_q1	0.820				
snorm_q2	0.876				
snorm_q3	0.888				
snorm_q4	0.840				

(H4), Subjective Norms - > AI Readiness ($\beta = 0.120$, p-value 0.011, $f^2 = 0.032$) (H5), Perceived Threats - > AI Readiness(-0.055, p-value 0.218, $f^2 = 0.009$).Out of five hypotheses tested, three were significant (H1, H3, H4) and two insignificant (H2 and H5 and therefore (H1, H3 and H4), significantly predicts teachers' AI readiness. From these path coefficients, AI ethics is the strongest predictor of readiness followed by confidence in AI and finally by the subjective norms.

The effect size (f2) serves as a measure of the degree to which individual exogenous variables elucidate an endogenous variable. As per the guidelines proposed by Cohen (1988), t is categorised as weak when it equals 0.02, moderate when it equals 0.15, and strong when it equals 0.35 as presented in Table 5. In addition, AI readiness demonstrates a strong predictive power with an R^2 value of 67.70% indicating a substantial proportion of variance in the data is accounted for by the model, suggesting a high level of accuracy and reliability in assessing AI readiness.

6. Discussions and implications

Because AI has such transformative potential, its integration into education has attracted great attention across the globe. The introduction of AI into K–12 classrooms around the globe has drawn particular attention because it fosters AI literacy and enables learners to develop the skills they need to thrive in the ever-evolving twenty-first century. It is important to know whether or not teachers are prepared to teach AI because their preparedness will affect how well AI education is implemented. This study therefore sought to understand the readiness of Kenyan in-service K-12 teachers on their preparedness to teach AI. Consistent with some previous studies, the findings of this study suggest that teachers' readiness to teach AI in schools is significantly predicted by their confidence in AI, AI ethics, and subjective norms. We also found that attitudes towards AI and perceived threats did not predict teachers' readiness.

Previous studies highlight teachers' confidence in AI as a significant predictor of their readiness to incorporate AI into school curricula (Ayanwale et al., 2022; Dai et al., 2020; Komarraju et al., 2013; Chai et al., 2020). This study's findings are consistent with these previous findings, which demonstrated that confidence was a significant predictor of teachers' readiness to teach AI. This demonstrates that confidence in AI affects how ready the teachers are to teach AI. The more confident they are, the more ready they will be. These findings therefore demonstrate the importance of providing professional development and interventions for teachers that improve their confidence in AI to prepare

Table 4
Heterotrait-Monotrait Ratio of Correlations (HTMT) of the constructs in the model.

	AI Ethics	AI Readiness	Attitude towards AI	Confidence in AI	Perceived Threats	Subjective Norms
AI Ethics						
AI Readiness	0.797					
Attitude towards AI	0.454	0.395				
Confidence in AI	0.633	0.789	0.354			
Perceived Threats	0.043	0.083	0.128	0.093		
Subjective Norms	0.513	0.549	0.458	0.486	0.105	

Table 5
Standardized path coefficient for tested model.

Hypothesis	Relationship	β	T statistics	P values	Effect Size($f^{2)}$	Remarks
H1	Confidence in AI - > AI Readiness	0.385	7.535	0.000	0.304	Supported
H2	Attitude towards AI - > AI Readiness	−0.004	0.060	0.952	0.000	Not Supported
H3	AI Ethics - > AI Readiness	0.473	8.803	0.001	0.411	Supported
H4	Subjective Norms - > AI Readiness	0.120	2.533	0.011	0.032	Supported
H5	Perceived Threats - > AI Readiness	−0.055	1.232	0.218	0.009	Not Supported

them to teach AI in schools.

This study found that teachers' readiness to teach AI was significantly predicted by their knowledge of AI ethics. The result suggests that teachers' knowledge of AI ethics prepares them to be ready to teach AI. This was consistent with previous studies (Borenstein & Howard, 2020; Chiu & Chai, 2020; Chiu et al., 2022) in which teachers' AI ethics knowledge fostered their confidence to teach AI in class, which in this study, confidence was also found to significantly predict teachers' readiness. This demonstrates the critical importance of integrating AI ethics into teacher preparation and professional development programs which will improve their confidence thus preparing them adequately to teach AI.

We found subjective norms significantly predicted teachers' readiness to teach AI. This demonstrates that perceptions about AI from the stakeholders around teachers affects the teachers readiness in teaching AI. This is because, the social pressure or perceptions determine different behaviours and when the subjective norms are favourable for the teachers, they will likely feel supported on the AI readiness journey. This is consistent with previous studies (Kimaiyo, 2016; Garcia & Oducado, 2021; Sadaf & Gezer, 2020; Sugar et al., 2004) that highlighted the impact of subjective norms on the adoption of AI-EdTech in the K-12 educational context. Additionally, Chiu et al. (2022) demonstrated that through an AI curriculum co-creation process, teachers enhanced teachers' knowledge of AI, indicating the importance of subjective norms in shaping teachers' confidence in AI which all predict their readiness to teach AI.

Attitude towards AI has been a subject of attention in many disciplines with some previous research indicating a strong connection between people's attitudes towards AI and their readiness/willingness to participate in AI-related activities (Lichtenthaler, 2020; Polak et al., 2022; Scott et al., 2021). This study, however, finds that attitude towards AI did not predict teachers' readiness to teach AI. These results are consistent with past research that found no correlation between teachers' attitudes towards AI and their readiness to teach AI (Lin & VanBrummelen, 2021). Zheng et al. (2021) study in the context of health care, found no relationship between the health workers' attitude and their willingness to use AI. This therefore implies that attitude may not always be a predictor of readiness for the use of AI.

While prior studies have highlighted perceived threats as a major predictor of readiness to engage with AI (Balakrishnan et al., 2021; Yu et al., 2023), this study's findings are consistent with the findings of Chiu and Chai (2020) that teachers perceived threats of AI did not predict their readiness to teach AI. Perceived threats did not predict teachers' readiness to teach AI. This could be attributed to the fact that the majority of the participants were of older age groups as supported by a previous study by Balakrishnan et al. (2021). Balakrishnan et al. (2021) research found that younger age groups may perceive more threat than older users, possibly due to the multi-function level available at the AI level and the young age group's usage intensity. Additionally, AI has been becoming more popular in Kenya, and is being adopted and therefore people perceive fewer threats from AI.

This study has several implications for the development and implementation of AI education in Kenya. The identified factors of confidence, AI ethics, and subjective norms are some of the key determinants in shaping the preparedness of Kenyan teachers to integrate AI into the curriculum.

First, to enhance teachers' confidence in AI, there is a need for teacher education and professional development programs in AI to be developed and rolled out to enable teachers to acquire the confidence they need to adapt and embrace the teaching of AI. This would include putting measures in place to prepare teacher trainers to run these programs. Additionally, while rolling out these capacity-building programs for teachers, it is imperative to create adequate awareness of AI ethics associated with AI technologies that would support the ethical and responsible use and development of AI. Further, considering subjective norms as a significant predictor, it demonstrates the need for a collaborative approach to AI integration in Kenyan schools where colleagues, administrators, and other educational stakeholders are involved. The approval of AI integration by these groups of people will make the teachers feel much more supported and thus potentially easier acceptance. Finally, the findings of this research provide some factors that would support the preparation of teachers in teaching to program designers and policymakers, helping them develop appropriate policies around AI education and integration the CBC.

6.1. Limitations and further work

This study utilised a sample size of teachers across Kenyan primary and secondary schools from 37 out of the 47 counties in Kenya, yielding valuable insights into teachers' readiness to teach AI. However, this sample size may not be representative enough to generalise the results to all teachers across the country. Consequently, we propose researchers in future studies consider an extended sample size across the 47 counties of Kenya as well as carry out comparisons across different counties, ages and grade levels. Further, we also exclusively utilised a quantitative approach in this study. This demonstrated that some factors were not supported, such as attitude towards AI, which was slightly different from largely what is the general expectation. To enhance this work in future, we propose a mixed-methods approach which may prove more efficacious in providing better insights. Additionally, we only gathered the

perspective of the teachers in finding out their preparedness levels to teach AI. We recommend that future investigations consider incorporating perspectives of other education stakeholders such as students, parents and educational management to provide a comprehensive understanding of how AI can be implemented in Kenyan schools. Finally, we propose that future studies should consider designing and developing an AI intervention program coupled with hands-on workshops tailored for educators for use in either cross-curricular school subject AI teaching. Such an intervention may support the gathering of well-informed perspectives on how to integrate AI into the school system.

6.2. Conclusions

This study sought to find out the preparedness of in-service teachers to teach AI in K-12 schools in Kenya. 308 teachers shared their perspectives through a survey administered on Google Forms in teachers' WhatsApp groups and during in person teacher training.

Some of the findings of this study align with the previous finding that AI ethics, confidence and subjective norms significantly predict AI readiness. These findings will be useful to schools, policymakers and teacher trainers to come up with an AI curriculum for teachers and learners as well as professional development programs to upskill in-service teachers that will enable the successful adoption of AI programs in schools. However, some of the findings of this study challenge some of the previously established findings that perceived threats and attitudes toward AI directly influence teachers' readiness to teach AI. This demonstrates the complexity of factors influencing educators' preparedness for teaching AI in different contexts from across the world.

CRediT authorship contribution statement

Maxwell Fundi: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Ismaila Temitayo Sanusi:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Solomon Sunday Oyelere:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Mildred Ayere:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix. Data collection tool

The data collection tool was based on a six-point Likert scale as follows.

SD – Strongly Disagree, **D –** Disagree, **SLD –** Slightly Disagree, **SLA –** Slightly Agree, **A –** Agree, **SA –** Strongly Agree.

Confidence in learning AI

I can facilitate AI learning in class
I understand the basics of AI

Interest in AI

I am interested in AI.
I would like to learn more about AI.
I am interested in how AI works.
I am interested in understanding how machines perform cognitive functions
I would like to study AI in the future.

AI readiness

I understand how AI technologies are trained and function in education.
I can distinguish the functions and features of different AI tools and applications.
I can effectively integrate AI technologies into my classroom routines.
I can effectively discuss, share, and collaborate with other teachers on the use of AI technologies to jointly design high-quality teaching solutions.
I understand the strengths and limitations of AI technologies.

AI Ethics

I understand the digital ethics that teachers should possess in the era of AI.
I understand the ethical obligations and responsibilities teachers need to assume in the process of using AI technologies.
I know how to keep personal information safe when using AI technologies.
I use the data of teachers and students generated by AI systems following legal and ethical norms.

Perceived threats from AI

I feel that AI technologies could weaken the importance of teachers in education.
I feel that the use of AI technologies has reduced the frequency of face-to-face communication with colleagues and students.
I think that frequent use of AI technologies to assist teaching and learning may lead to inertia, which may reduce the thinking and decision-making abilities of teachers and students.
In my opinion, overuse of AI technologies may reduce the necessity of human teachers in the classroom, rendering it difficult for teachers to pass on correct values to students.

Attitude toward AI

I look forward to using AI in my daily life.
I would like to use AI in my teaching.
It is important that my students learn AI.
It is important that my future students acquire the necessary abilities to take advantage of AI.

Subjective norms

My school organizes enrichment lessons for us to learn more about AI technologies
My peers encourage me to participate in innovative AI learning activities

My mentors/bosses have emphasized the necessity to work creatively using AI technology
My colleagues feel that learning how to work with AI technology in education is necessary

Relevance of AI

Learning AI in class will be useful
AI content will be related to things I have seen, done or thought about in my own life
It is clear to me how the content of AI is related to my career
The content of AI will be useful for me
I am aware that AI technology will change the world.

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