

RESEARCH ARTICLE



The Role of AI in Shaping Future Educators: Ethics, Instructional Design, and Lifelong Learning

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Abstract: The rapid integration of artificial intelligence (AI) into higher education is reshaping how future educators are prepared for multilingual, multicultural, and ethically complex environments. This study employed a mixed-methods sequential explanatory design to investigate how educators and students in Luxembourg and Ukraine perceive and adopt AI in teacher preparation. In Luxembourg, AI was largely framed as a tool to extend inclusive, multilingual practices and institutional innovation, whereas in Ukraine, it was often adopted out of necessity under conditions of crisis and infrastructural disruption. Quantitative analyses demonstrated that perceived benefits of AI were positively correlated with readiness for instructional integration ($r = 0.61, p < .001$), while ethical concerns were negatively correlated with willingness to adopt AI ($r = -0.45, p < .001$). No significant group differences were observed in overall reported levels of ethical concern ($t(140) = 1.25, p = .21$), though qualitative findings revealed striking contrasts in the nature of these concerns. Luxembourgish participants expressed preventative concerns about quality and pedagogy, while Ukrainian participants described immediate ethical dilemmas shaped by wartime conditions, including studying in bomb shelters and balancing personal safety with academic integrity. Findings highlight that while AI can enhance instructional innovation, it simultaneously amplifies inequalities through language bias and access gaps. The study contributes by linking empirical insights to instructional design frameworks (ADDIE, TPACK) and multicultural education theory, offering concrete guidance for teacher preparation in both stable and crisis-affected contexts.

Keywords: AI in education, future educators, ethics, lifelong learning, multilingual higher education, multicultural contexts, multicultural pedagogy and translation, AI literacy

1. Introduction

Artificial intelligence (AI) is rapidly reshaping the landscape of education by offering unprecedented opportunities for personalization, automation, and data-informed decision-making. In higher education, and particularly in teacher training programs, AI tools such as generative language models (e.g., ChatGPT, Gemini, Claude), predictive analytics, intelligent tutoring systems, and machine translation platforms are becoming increasingly embedded into instructional design and assessment [1, 2]. These developments are prompting educators and researchers to reconsider how multicultural future educators are prepared to engage with such technologies as users, as critical practitioners, and as lifelong learners

[3, 4]. Moreover, as education systems worldwide adapt to technological disruption, the role of teacher education extends beyond academic preparation; it becomes a strategic function of human capital development. Future educators represent a vital segment of the education sector's workforce, and their training must align with broader goals of workforce resilience, digital fluency, and ethical leadership, inasmuch as "job mismatch is perhaps a manifestation of credential inflation; it has also been called mal-employment or [...] the overproduction of elites" [5]. In this sense, the integration of AI into teacher education parallels ongoing trends in human resources (HR), where AI-supported professional development [6], ethical technology adoption [7, 8], and intercultural competence [9] are increasingly viewed as essential components of long-term institutional sustainability [10, 11].

Recent scholarship has increasingly recognized AI's transformative potential in educational settings. Studies demonstrate that AI technologies can significantly enhance educational efficiency [12, 13] while providing robust support for adaptive learning

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environments [14, 15]. For institutions serving multilingual or linguistically diverse populations, AI systems hold substantial potential to advance multilingual accessibility [9, 16] and reduce enduring language-related barriers.

Nevertheless, these promising developments are accompanied by substantial concerns that educational researchers and practitioners cannot ignore. Literature reveals persistent anxieties about algorithmic bias, which may inadvertently perpetuate existing educational inequities. Data privacy concerns and questions surrounding academic integrity have intensified as AI-generated content becomes more sophisticated and accessible to students. At a more fundamental level, concerns are mounting about the potential erosion of pedagogical agency [7, 17], with educators increasingly grappling with shifting roles in automated educational settings.

While educational policy researchers and technology infrastructure specialists have begun engaging seriously with these debates, a critical gap remains in our understanding. Specifically, there is a marked absence of comparative empirical research that examines how pre-service teachers, particularly those from diverse cultural and linguistic backgrounds, experience and respond to AI technologies during their professional formation. This gap is growing more concerning given that future educators will be responsible for implementing AI-enhanced pedagogical approaches in tomorrow's classrooms, yet their voices and experiences remain largely absent from current discussions about AI integration in teacher preparation programs.

Notably, few teacher education programs currently incorporate AI literacy as a structured component of pedagogical training, given that "AI-powered analytics and learning management systems have revolutionized the collection and analysis of student data, enabling educators to gain valuable insights into student progress and performance" [18, 19]. Even fewer address the ethical, sociocultural, and long-term implications of AI adoption in multilingual and multicultural classroom settings, including post-conflict or transitional education systems [20]. Existing literature tends to focus either on technical affordances or macro-level policy frameworks, leaving a significant gap in applied, practice-oriented research that can inform curriculum design and educator preparation. From an HR perspective, this gap also indicates an urgent need to develop educators not only as academic professionals but also as adaptable, ethically grounded contributors to institutional and societal transformation.

This study sought to bridge a critical research gap by examining the multifaceted role of AI in preparing a new generation of multicultural educators, drawing on empirical evidence from surveys and interviews with teachers in Luxembourg and Ukraine, where we explored how AI shapes pedagogical development, fosters ethical awareness, and builds essential lifelong learning competencies, particularly within the linguistically diverse environment of higher education. We explicitly position this as an empirical comparative study employing a mixed-methods sequential explanatory design, integrating quantitative survey results with qualitative interviews across Ukraine and Luxembourg. Our investigation focused on three core areas: the specific methods for integrating AI tools into instructional design in teacher education, the perceptions and evaluations of these tools by both students and instructors, and the ethical, practical, and pedagogical challenges that emerge from their use. We stress that the professional preparation of AI-trained future educators is a strategic imperative for human resource development, leading this research to contribute to broader discussions on digital upskilling, sustainable workforce readiness, and responsible leadership in the education sector.

To meet this aim, the study pursued the following objectives: (a) to examine how AI tools are embedded in the instructional design

of multilingual teacher education programs as part of strategic capacity building, (b) to analyze how multicultural future educators perceive and ethically evaluate their engagement with AI technologies in relation to their professional development, (c) to identify the perceived benefits and challenges of AI use for building workforce readiness and intercultural competence, and (d) to propose a framework for the responsible and pedagogically meaningful integration of AI in teacher education programs.

To address these gaps, this study was guided by the following key research questions:

- 1) How are AI tools currently incorporated into the curricula of teacher education programs within multilingual higher education settings?
- 2) What are the ethical concerns raised by future educators regarding the application of AI in their own learning and future multicultural teaching practices?
- 3) In what specific ways does the use of AI either support or impede the cultivation of lifelong learning skills among future educators from diverse backgrounds?
- 4) What are the principles that can inform the responsible design and implementation of AI in teacher training?

With these questions answered, it is assumed that the study offers a foundational contribution to the academic discourse on the responsible integration of AI into teacher education and may serve as a practical guide for policymakers and educators seeking to align curriculum innovation with the principles of equity, adaptability, and sustainability for professional growth in a digital-first world.

2. Literature Review

With the increasing trend of researching and integrating AI in higher education, more and more publications have been devoted to the topic. However, a close analysis of the existing literature reveals that key concepts often center on four core areas: the overarching trends and challenges of AI in education, the intersection of AI with ethical and human resource management principles, its role in instructional design, and its specific application within multicultural education contexts.

2.1. AI in higher education: Trends and challenges

Today, AI is widely recognized as a major force influencing educational practices [2, 21]. While Williamson and Eynon [17] highlight the historical and epistemological challenges this transformation presents, mentioning also the imbalance between AI and pedagogy, other scholars are focused on finding solutions with different paths. Thus, Luckin et al. [3], for instance, advocate for a new relationship between human and artificial intelligence, arguing that ethically responsible and context-sensitive educational environments hinge on socio-technical integration. This perspective aligns with Gagnon's [4] framework for AI platform selection in small businesses, which can be applied to educational institutions to support long-term human capital development. These contributions reveal a shared recognition of AI's transformative promise but diverge in their emphasis, shifting the focus from diagnosing structural gaps to proposing actionable, interdisciplinary frameworks for future-oriented education. Additionally, this divergence in approach is further highlighted by others. For example, a systematic review by Zawacki-Richter et al. [2] confirms a persistent gap in the field, with technological innovation progressing faster than pedagogical integration. It is also this technology-centered discourse that Holmes and Tuomi [1] counter, underscoring the vital need to align AI tools meaningfully with the needs of multifocal, multilingual, and

multicultural learning environments. From this perspective, the emphasis is laid on a learner-centered rather than tool-based, where orientation is becoming a prominent consensus in the literature.

2.2. Ethical and institutional implications of AI integration

Other research niches delve into the intersection of AI with human resource management, highlighting both ethical dilemmas and the strategic potential of integrating AI into institutional and educational settings. Accordingly, this study anchors its ethical lens in widely accepted AI ethics principles such as beneficence, non-maleficence, autonomy, justice, and explicability [22], as well as in EU-level requirements for transparency, accountability, and risk classification [21], making these concerns directly actionable for teacher education policy and practice.

Cascio [10] positions AI as a dual force, capable of both enabling training innovation and creating new ethical tensions around surveillance, bias, and accountability. This is expanded upon by Rodgers et al. [23], who offer algorithmic models for ethical decision-making in HRM. These models, with their focus on recruitment and evaluation, are highly transferable to higher education, where similar dilemmas arise in faculty selection and learner analytics.

Building on this, Kreutzer and Sirrenberg [6] provide a cross-sectoral analysis, showing how education, healthcare, and HRM all share concerns over data privacy, operational transparency, and the potential erosion of human agency. While Rodgers et al. [23] concentrate on algorithmic ethics, Kreutzer and Sirrenberg emphasize the broader structural and systemic implications. Mahendrakar and Soundararajan [11] further contribute a framework for AI-driven performance management that prioritizes adaptability, transparency, and human oversight, viewed as principles increasingly critical to educational governance. Collectively, these studies establish a clear consensus on the need for ethical implementation of AI, which demands a careful balance between technological efficiency and human-centric values, especially when models from corporate environments are applied to academic ecosystems.

2.3. Instructional design considerations for AI in higher education

These days, more scholars are turning their focus to the integration of AI tools into instructional design, especially to foster personalized and adaptive learning. Some works, for example, by Gligorea et al. [15], provide comprehensive reviews of adaptive learning in e-learning with a strong emphasis on enhancing learner autonomy. However, this discourse was criticized for being overly technical and user-centered. In response, other scholars, for example, Er-Rafy et al. [14], broadened the conversation to include systemic challenges, such as institutional readiness and scalability. While both studies recognized AI's pedagogical potential, Er-Rafy et al. [14] introduced a crucial note of caution about infrastructural and equity-related limitations that others had only briefly acknowledged.

The field has since evolved, moving away from static instructional models toward more dynamic, co-created learning ecosystems. For instance, Mekić et al. [13] shifted the focus to DevOps practices and generative AI chatbots, highlighting the collaborative roles of both learners and educators in shaping these new environments. This approach stands in contrast to the structured, cognitive-focused work of Hmoud and Shaqour [12], who proposed the AIED Bloom's Taxonomy Model. Further, it is not supposed to

prioritize some works over the others; it is stressed that while Mekić et al. champion flexibility and innovation, Hmoud and Shaqour move to the front cognitive precision and pedagogical intentionality.

Furthermore, adding another dimension, Lamb et al. [20] explore "post-digital" learning spaces where AI's function is instrumental, as well as socially embedded. This perspective is complemented by Miranda and Vegliante [16], whose research on AI-generated multilingual virtual speakers is especially relevant for multicultural educator training. Their work fills a key gap by explicitly connecting AI with language diversity and intercultural competence. Ultimately, the literature suggests that the meaningful adoption of AI in instructional design [24] requires a careful balance between technical innovation, pedagogical relevance, and cultural inclusivity.

This balance can be further contextualized through established instructional design frameworks: the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) provides a structured sequence for integrating AI into curricula [25], while the TPACK framework (Technological Pedagogical Content Knowledge) highlights the interdependence of content, pedagogy, and technology in shaping educators' adaptive expertise. Referencing these models enabled us to situate our empirical findings within broadly recognized theoretical scaffolds, while acknowledging that in both Luxembourg and Ukraine, AI adoption was experienced less as a prescriptive sequence and more as a dynamic, adaptive process.

At the same time, it should be emphasized that while widely used tools such as ChatGPT, Gradescope, or Ecree illustrate practical applications, this study did not undertake a tool-by-tool evaluation. Instead, our focus remained on how educators in Luxembourg and Ukraine perceive and adapt to AI adoption within their institutional and cultural environments.

2.4. AI in multicultural and cross-cultural education

A deeper analysis of literature adds more value to an examination of trends in AI in education, showing a critical shift from a technology-first approach to a learner-centered one, while also highlighting the persistent imbalance between technical innovation and pedagogical integration, on the one hand. On the other hand, a review of research on ethics and human resource management provided a framework for understanding AI's strategic potential and the associated challenges of bias, privacy, and accountability, all of which were found highly relevant to academic contexts and our research, in particular. Then, an analysis of instructional design literature provided a demonstrated move from static learning models to dynamic, co-created environments, underscoring that meaningful AI integration depends on balancing innovation with pedagogical relevance and cultural inclusivity [1].

What was found critical for multicultural educational settings is the inclusion of the need for cross-cultural communication aspects when integrating AI tools into curriculum design [18, 19]. However, it should be noted that integrating AI into multicultural education may present considerable complexities along with significant opportunities. It is agreed with Saddhono et al. [9] that a key aspect of this is how AI can support multilingual literacy and cross-cultural understanding. The scholars also issue a crucial warning, emphasizing that such systems must be deliberately designed to mitigate cultural bias and ensure inclusivity. In our understanding, it is a concern that is part of a wider academic discussion on the ethical deployment of AI in diverse educational contexts.

Besides the technical design, the conversation should also address the human element. As reasonably noted by Nelson [7], more studies should examine the profound impact of AI on academic

identity itself, raising fundamental questions about how educator preparation programs must adapt to new professional roles and self-perceptions in AI-rich environments. This is complemented by the work of Alexander and Belloni [5], who propose a sustainable integration framework that sees AI not as a replacement but as an amplifier of human capital. Their work underscores the necessity of preserving educators' agency and cultural competence while still leveraging AI's efficiencies.

From the above, it is summarized that these contributions collectively depict a nuanced landscape where AI's promise in multicultural education is contingent on a careful blend of ethical design, professional adaptation, and strategic institutional governance. This body of work is expected to move the academic trend, considering the multi- and cross-cultural communication framework in education from specific technical challenges to a systemic model that balances innovation with cultural and institutional sustainability.

2.5. Current gaps and directions for research

While significant progress has been made in AI-assisted instructional design [16, 26] and ethical frameworks [8, 27], several gaps remain: limited empirical studies on AI's impact on multicultural educator identity formation, as well as a lack of integrated models combining ethics, HR, pedagogy, and technology in teacher preparation. In addition, few studies have analyzed the longitudinal effects of AI-enhanced training for future educators across diverse cultural backgrounds. This leads to the present study that builds on these findings by bridging ethical AI integration, instructional design, and multicultural readiness in training future educators. Drawing from recent scholarship [7, 17–19], it aims to contribute a holistic perspective that integrates technological affordances with pedagogical, ethical, and cross-cultural frameworks.

3. Research Methodology

This study employed a mixed-methods sequential explanatory design [28], combining quantitative and qualitative data to investigate the role of AI in shaping multicultural future educators. This approach allowed for the triangulation of findings, leveraging the breadth of numerical data with the depth of contextual insights.

3.1. Research design

To meet the aim and objectives of the study, it was found logical to unfold it in two complementary phases. The initial quantitative phase was conducted exclusively in Ukraine and involved structured surveys with a sizable sample of pre-service educators and university faculty in Kyiv and Kryvyi Rih. The phase was designed to provide generalizable data on participants' perceptions of AI, ethical concerns, and attitudes toward AI-supported instructional practices. This was followed by a qualitative phase, which was carried out in both Luxembourg and Ukraine. In Luxembourg, that involved guided reflective group discussions and one-on-one dialogues with student teachers and academic staff, often emerging organically from regularly scheduled pedagogical debriefs. Meanwhile, in Ukraine, the insights were mainly gathered through semi-structured interviews with a subset of the original survey participants. Together, these two phases offered a rich, cross-contextual exploration of how future educators and academic professionals engaged with AI at the intersection of ethics, instructional design, and cultural diversity in two European but distinct higher education systems.

3.2. Participants

The study adopts the term “future educators” to refer interchangeably to student teachers (in Luxembourg) and pre-service education students (in Ukraine) enrolled in programs designed to prepare them for classroom teaching (FEPs, or future educator participants). Thus, the study involved a total of 142 male and female participants, divided across two national contexts and professional groups. In Ukraine, the sample comprised 98 respondents: 76 FEPs, that is, pre-service educators (bachelor's and master's students in pedagogical and philological faculties), and 22 FSPs (faculty staff participants), who are university faculty members from Kyiv and Kryvyi Rih (Ukraine). These participants were recruited from two state universities, selected for their established programs in education and teacher training. In Luxembourg, 44 participants were involved: 36 FEPs enrolled in multilingual education and inclusive pedagogy programs, and 8 FSPs engaged in curriculum development and pedagogical innovation. These three institutions were selected due to their active involvement in teacher education and AI-enhanced instruction initiatives.

Sampling followed a purposive and convenience-based logic, considering participants' ongoing exposure to digital technologies in education and their involvement in classroom-level or curricular decisions related to AI. All participants gave informed consent, and participation was voluntary. A significant difference between the two groups lay in their linguistic repertoires, which shaped but did not limit their engagement with AI in multicultural contexts. In Luxembourg, all students possessed a minimum of four to five working languages. This included Luxembourgish, German, French, and English, which were taught from early schooling, plus an additional heritage or family language (commonly Portuguese, Spanish, Italian, or Slovak). We observed that such linguistic dexterity is characteristic of Luxembourg's plurilingual education system and often reflected in the metalinguistic awareness of FEPs.

In this study, a typical Ukrainian participant displayed a high degree of trilingual or, in fewer cases, quadrilingual proficiency. The most common combination of languages included Ukrainian, Russian, and English, with a smaller group also fluent in a fourth language, mainly these were German, French, Polish, or Czech. Although formal multilingualism might not have been our primary focus, many of these participants had a remarkable ability to switch between languages, particularly in online and professional communication, signaling good translanguaging linguistic competencies.

Despite the abovementioned cultural and linguistic differences, participants from both locations expressed nearly identical worries about integrating AI into their work. The FSPs on their end frequently brought up the ethical issues surrounding automated feedback, a lack of clear educational policies on data privacy and ownership, the difficulty of using AI tools in a way that truly serves students, and a sense of uncertainty about their own roles in a profession that is becoming increasingly automated. This convergence of concerns highlighted that the challenges posed by AI are universal and that a background in multiple languages did not make future educators any less susceptible to the complex ethical and pedagogical questions that would come with AI-enhanced teaching.

3.2.1. Data collection instruments

To comprehensively explore the role of AI in shaping multicultural future educators, the study utilized two distinct but complementary data collection instruments aligned with its mixed-methods design [29]. One of them was the quantitative instrument, that is, an online survey [30, 31]. For the Ukrainian cohort, a

structured online survey was developed and distributed to pre-service educators and faculty members. The survey consisted of four main sections: (i) demographic and linguistic background to capture age, gender, language proficiencies, and educational level; (ii) perceptions of AI in education, where Likert-scale items assessed familiarity with AI tools, perceived benefits, and concerns related to ethical AI use; (iii) instructional design and AI integration through measuring attitudes toward AI-supported teaching strategies, adaptive learning systems, and curriculum innovation; and (iv) lifelong learning and professional readiness, in which items focused on self-assessed preparedness for continuous learning and ethical application of AI.

To explore the complex issue of AI integration in multicultural education, we used a dual-method approach. First, we created a survey instrument where we combined established scales from past research with original questions specifically designed for the unique multicultural and multilingual environment of Ukrainian higher education. To ensure the survey's quality, we first piloted it with a small group of students and faculty. This initial phase was crucial for checking the clarity and relevance of our questions and confirming that the language was easily understood by people from various linguistic backgrounds. Feedback from this process led to minor but significant revisions, such as simplifying complex sentences and adjusting response options to better reflect local cultural and linguistic norms.

A key insight from our piloting process was that the Russian survey questions had to be deliberately reframed using a negative grammatical framework to sound natural to bilingual native speakers, that is, a native Russian and Ukrainian speaker as opposed to a native Ukrainian and Russian speaker. This stood in sharp contrast to the Ukrainian version survey, which, similarly to its English translation, could be formulated using a more direct and positive grammatical structure. For example, a question about using AI for thesis writing had to be rephrased with a negative grammatical structure in Russian: *Нежелали Вы схитрить и воспользоваться ИИ, например, ChatGPT, для написания магистерских и бакалаврских работ, чтобы сэкономить время?* (*Did you not want to act smart and take advantage of AI, e.g., ChatGPT, to write your master's or bachelor's thesis to save time?*). Conversely, the Ukrainian version remained unchanged and would come as a much more literal and direct translation in English: *Чи спадало Вам на думку скористатися ІІІ, наприклад, ChatGPT, для написання магістерських/бакалаврських робіт для економії часу?* (*Did it occur to you to use AI, e.g., ChatGPT, to write your master's/bachelor's thesis to save time?*). This careful refinement ensured the final survey was both valid and appropriate before its widespread use. It reflected the opposing grammatical frameworks and ensured that our instrument would not inadvertently influence responses based on linguistic structure. These revisions were a critical methodological step to make our survey culturally sensitive and linguistically appropriate, thereby strengthening the reliability and validity of our data across both languages, Ukrainian and Russian, from the perspectives of bilingual native speakers in Ukraine.

Second, we gathered qualitative data through reflective discussions and interviews, which provided valuable depth and context beyond the survey results [32, 33]. In Luxembourg, where this phase was particularly focused, we held group discussions during regular reflection practices. These sessions gave future educators and faculty a chance to openly share their experiences and ethical reflections on using AI. The discussions were guided by a semi-structured framework based on themes from our quantitative phase. To get an even deeper understanding, we conducted one-on-one interviews

with willing participants. For both discussions and interviews, we audio-recorded the sessions with participant consent and transcribed them. Facilitators took notes to capture important non-verbal details and contextual cues. This dual methodology allowed us to build a comprehensive picture, blending the broad insights from the surveys with the rich, personal narratives from the interviews and reflective discussions.

3.2.2. Data analysis procedures

As presented above and to analyze our findings, we used a combined approach. The pilot survey allowed us to trace subtle differences in how native speakers in Ukraine, whose first language was either Ukrainian or Russian, perceived certain questions. This led to grammatical adjustments in questions when we considered the linguistic nuance to ensure cross-cultural validity. The result was a more reliable instrument.

For the quantitative survey data, we used descriptive statistics to summarize participant demographics and overall responses. We then performed correlation and regression analyses to explore the relationships between attitudes toward AI, ethical concerns, and readiness for instructional integration.

For the qualitative data, which came from our reflective discussions and interviews, we transcribed the conversations and analyzed them using a thematic approach. We systematically coded the data to identify key themes related to ethics, instructional design, AI's role in future careers, its influence on human capital, and lifelong learning. This combined methodology allowed us to develop a comprehensive understanding of how future educators and academic staff perceive and engage with AI in multicultural settings. The reliability of our findings was further strengthened through triangulation, as we compared insights from group discussions with those from the individual interviews.

4. Results

Of the 142 participants, 98 (69%) were from Ukraine and 44 (31%) from Luxembourg. The Ukrainian cohort was drawn from two universities, with each institution contributing approximately 35% of the total participants. Descriptive statistics revealed a high level of familiarity with AI tools among both groups. On a 5-point Likert scale (1 = Not at all familiar, 5 = Extremely familiar), we observed the average self-assessed familiarity of 3.9 (SD = 0.8) for Ukrainian participants and 4.1 (SD = 0.7) for Luxembourgish participants.

4.1. Perceptions and ethical concerns of AI in education

Survey results from Ukrainian participants showed a generally positive attitude toward AI's potential to enhance personalized learning. However, despite this optimism, significant ethical concerns emerged. As specified in Table 1, the survey found that 68% of Ukrainian participants agreed that AI tools personalize learning effectively. At the same time, 72% considered ethical issues (privacy, bias) to be a major concern, and 85% believed clear ethical guidelines for AI use are necessary. These results empirically demonstrate that while Ukrainian educators recognize AI's pedagogical potential, they simultaneously express acute awareness of ethical risks, underscoring the urgent need for training and institutional guidance.

In correlation and regression analyses, we found a significant positive relationship between a participant's perceived benefits of AI and their self-assessed readiness for instructional integration

Table 1
Perceptions and ethical concerns about AI in education (Ukraine, $n = 98$)

Statement	Agree, %	Neutral, %	Disagree, %
AI tools personalize learning effectively	68	20	12
Ethical issues (privacy, bias) are a major concern	72	18	10
Clear ethical guidelines for AI use are necessary	85	10	5

($r = 0.61$, $p < .001$). However, further analysis showed that ethical concerns were negatively correlated with the willingness to integrate AI tools ($r = -0.45$, $p < .001$), suggesting that participants' reservations about ethics acted as a barrier to adoption. Next, the findings revealed no significant difference between the two groups in their overall reported levels of ethical concern ($t(140) = 1.25$, $p = .21$). It was the qualitative data that provided crucial context, revealing that the nature of these concerns differed significantly based on lived experiences. Taken together, the results show that AI in education can both advance and hinder instructional goals, with benefits linked to readiness and risks tied to unresolved ethical concerns.

Qualitative data revealed that participants in both countries expressed heightened ethical caution, with FSPs emphasizing the need for robust regulatory frameworks. For instance, FEP22 from Luxembourg remarked on the dual nature of AI, stating that while it offers support for multilingual learners, "transparency in algorithm decisions remains a concern." A dominant theme was concerns over cultural bias and stereotyping, which was more traceable from comments by Ukraine's FEPs, although Ukraine is less multiculturally represented in university settings as compared to Luxembourg. Additionally, in Ukraine, several FSPs noted that localized AI tools, often trained on monolingual data, were less effective or even problematic in multilingual and multicultural environments.

Along a similar vein, we saw a lot of concern about data privacy and consent, particularly when it came to vulnerable groups, according to FEP13 from Luxembourg: "Protecting student data is crucial, especially when working with vulnerable groups in multicultural classrooms."

The findings showed participants' concerns when they warned against teachers' becoming too dependent on AI, commenting less or hardly at all, mentioning their (students') reliance on the use of AI tools. Consequently, both FEPs and FSPs feared that AI integration in education could lead to teachers losing their skills or a general decline in human connection. Ukrainian respondents voiced such sentiments as "There is a risk that our teachers may delegate too much authority to AI tools ..." (FEP34), as well as they stressed that "human judgment and empathy are irreplaceable in multicultural education" (FEP71). Similarly, another respondent said, "I worry that in our rush to find solutions, we'll start relying on AI too much" (FSP14) that echoed with another reply, "We [Ukrainian professors] are lucky today (if we may see it as 'luck') that our administration cannot support us with paid plans of digital tools accounts" (FSP18). These qualitative accounts provide strong empirical grounding for the argument that educators in Ukraine critically reflect on both the promises and risks of AI, particularly regarding ethics and human-centered pedagogy.

In further discussions, when this topic was brought up for reflection, the answers focused on the need for human judgment and empathy that today matter to them most. Faculty find it critical that machines cannot decide what is best for a student, especially as students' personalized learning paths are shaped by the ongoing armed conflict in Ukraine and threats to students' safety and survival under attacks.

This and other revealing findings were related to the war in Ukraine, which, as commented by FSPs, had been pushing them to limits, with many faculty staff having to grade papers and plan lessons from places unconventional for European educational settings (basements, cellars, and bomb shelters). Such places were most often mentioned by FEPs, too, in connection with the use of AI tools for personalized learning, making it less efficient for technical reasons, for example, slow or unstable internet connection, impossibility to complete the assignments because of lost signals, and the need to start over from the beginning. Some FEPs confessed to unethical use of the tools and the time pressure. For example, "I've had to use ChatGPT to finish my thesis" (FEP47), and when asked in an individual interview for reasons why, the reply might have been expected, "With the constant power cuts and studying in the shelter, there just wasn't enough time to do it all on my own."

It was obvious to trace shared concerns about the use of AI by both Ukrainian and Luxembourgish participants; however, the nature of those fears was fundamentally different. The Luxembourgish participants focused on theoretical and preventative issues, and their concerns stemmed mainly from a desire to maintain quality in education, while Ukrainian participants faced immediate, existential ethical problems driven by the ongoing armed conflict in Ukraine. Their use of AI was often out of necessity, where they had to meet deadlines (FSPs and FEPs) despite power cuts and studying in bomb shelters. This was discovered as a conflict between academic integrity and survival. This finding particularly highlights how their concerns were rooted in a daily struggle for educational continuity, rather than a hypothetical future. This contrast illustrates how AI can both mitigate inequalities in resource-rich contexts such as Luxembourg, while simultaneously amplifying inequities in crisis-affected Ukraine, where access gaps and survival imperatives constrain equitable adoption.

Ultimately, the study resulted in seeing language as dual-faced: a great strength and a significant barrier. While AI tools were reported by FEPs as fantastic for supporting multilingual learning now and for the future, their performance was uneven across languages. FEPs from Luxembourg noted they used ChatGPT and other platforms mainly in French and English as compared to German, which emphasized the language's large digital presence. At the same time, it leads to conclude that Ukrainian and Luxembourgish are less represented online, for example, "When I was preparing my master's and I used ChatGPT, it was frustrating" (FEP27) and "Asking ChatGPT to help me with the literature review, it couldn't do it and all the time hallucinated giving names of non-existing Ukrainian scholars and using many Russian and English calques in the text" (FEP13). This challenge might be explained that in Ukraine, master's and bachelor's theses must be written in the state's official language – Ukrainian, which is why students often complain about the poor quality of AI-supported learning or preparation of their projects. Another comment stressed out emotional aspect of AI use in Ukraine, "It feels like we're being left behind" (FEP39). These examples reveal how AI adoption can unintentionally amplify inequalities in multilingual contexts, privileging globally

dominant languages while marginalizing those with weaker digital presence.

Luxembourgish students were less affected. As presented above, FEPs primarily used AI tools in French or English for their studies, and they used Luxembourgish in breaks or after classes for informal communication mainly. This stark difference highlights how the digital marginalization of a language can inadvertently reproduce hierarchies and limit its full integration into AI-driven education.

4.2. Attitudes toward AI-supported instructional design

The quantitative data under the study revealed a nuanced readiness among Ukrainian FSPs to integrate AI into their teaching. It was observed that many felt moderately prepared as evidenced in Table 2 on *self-assessed preparedness to use AI in instructional design*, and it could be explained with certain practical barriers, such as limited institutional infrastructure for paid plan accounts and workshops (a lack of formal training) and a clear strategic direction, as other areas in education under the current developments had been prioritized by university administrations.

This result contrasted sharply with the experience in Luxembourg. Table 3 *Comparative Confidence in AI Use among Participants* displays that in Luxembourg, both FSPs and FEPs expressed high confidence, though for different reasons. Academic staff attributed their readiness to being actively involved in curriculum development and having the freedom to experiment with new AI solutions. In addition, ethical guidelines are being developed. Meanwhile, FEPs, who are already highly digitally and linguistically proficient, felt confident from their frequent, day-to-day interactions with adaptive technologies.

Despite these differing contexts, certain shared themes emerged. All participants from Luxembourgish and Ukrainian educational settings agreed that AI should be a complement, not a replacement, for a teacher. FEPs and FSPs stressed the need for AI implementation to respect cultural and linguistic diversity, and they believed ongoing training and ethical conversations should be regarded as crucial for making AI a sustainable part of education.

The research yielded qualitative comments that helped take a clearer picture of these dynamics in practice. For instance, a

Luxembourgish student described using AI for out-of-class progress in linguistic competencies, “*I use AI chatbots for practicing pronunciation...*” and explained that “*it helps me speak better and builds my confidence*” (FEP8). In Ukraine, however, the focus was often on systemic challenges. One educator’s survey comment highlighted this, “*We don’t yet have enough institutional support or even trainings to confidently use AI tools in curriculum preparations or lesson plans*” (FSP14).

From the above, it may be seen that Luxembourgish FSPs benefit from a more supportive institutional environment, while the Ukrainian FSPs show incredible adaptability and a strong potential for innovation despite very challenging conditions. These findings suggest that to empower future educators everywhere, strategic investment in professional development and infrastructure is essential.

4.3. Readiness for lifelong learning with AI

The findings show that educators in both countries recognize the importance of staying current with AI, but their ability to do so is shaped by vastly different circumstances. Table 4 displays the difference between the educational backgrounds in Ukraine and Luxembourg.

In Ukraine, the survey data revealed a strong commitment to lifelong learning, with participants understanding the need for ongoing AI competency development for future careers. However, almost every second participant realizes this is significantly hampered by a lack of access to formal training; only 36% of future educators reported having access, while a striking 64% had no access at all. In interviews, it was explained by financial burden given that most training programs are carried out at personal cost despite some Ukrainian FEPs admitted their chances of studying free of charge under university partners’ grant/disclaimer fee options but they could hardly ever implement it due to poor study quality for technical issues (internet stability) and mental/emotional health (constant stress, lack of sleep and self-determination, time and energy management, etc.). As noted in an individual interview, “*Continuous training in AI ethics could help me understand to which extent I can use AI for my year projects*” (FEP31), which was supported by another comment, “*Such trainings [AI formative] should be mandatory in our programs*” (FEP66). These findings reveal that the means to deliver such trainings in Ukraine are often unavailable, and it may be assumed this is most likely to be attached to the impact of the ongoing military conflict that presents a unique and severe barrier. Based on an excerpt of reflection in the Ukrainian group, “*Even though our students are digitally fluent, many study in bomb shelters with no internet. . .*” (FSP6) and “*Implementing AI tools in such conditions is close to impossible*” (FSP19). This highlights the harsh reality that even a strong commitment to personal and professional development can be undermined by a lack of basic infrastructure.

Table 2
Self-assessed preparedness to use AI in instructional design
(Ukraine, n = 76 future educators)

Preparedness Level	Percentage
Well prepared	20
Moderately prepared	63
Unprepared	17

Table 3
Comparative confidence in AI use among participants

Group	Confidence Level (LU)	Confidence Level (UA)	Reasons for Confidence/Hesitation
FEPs	High	Moderate to high	(LU) Tech-savvy, multilingual, used to educational apps (UA) Self-trained, enthusiastic but cautious
FSPs	High	Mixed	(LU) Engaged in curriculum design, supported experimentation (UA) Varies by training; lack of institutional support

Table 4
Access to AI training programs (Ukraine, *n* = 76 future educators)

Access Level	Percentage
Have access	36 %
No access	64 %

In Luxembourg, the situation was much more supportive from the comments of participants. FSPs and FEPs reported an institutional culture that actively promotes AI literacy and ethical use. Academic staff admit having regular access to digital innovation workshops and resources, which a professor noted *“really helps keep us updated”* (FSP3). This proactive approach is reflected in students as well: *“Developing critical digital literacy and ethical judgment is essential. . .”* (FEP15); *“it helps students understand how AI systems function”* (FEP21), and *“our professors explain to us how to question AI generated outputs”* (FEP2).

As displayed, participants from both countries share similar values and see the need for lifelong learning in AI. Nevertheless, the Ukrainian context vividly illustrated how military conflict and lack of infrastructure can directly impede the application of those values as contrasted with the Luxembourgish educators who benefit from a supportive institutional ecosystem. Their Ukrainian counterparts yet show remarkable adaptability and commitment under far more challenging conditions.

5. Discussion

The integration of AI into higher education is a topic that incites both enthusiasm and caution. A consensus in academic literature suggests that AI can personalize learning, automate administrative tasks, and foster inclusive educational environments [2, 14, 15]. However, our study of Luxembourg and Ukraine reveals the tangible tension between this potential and its practical implementation, especially when comparing a well-resourced system with one affected by crisis.

Scholars like Luckin et al. [3] and Holmes and Tuomi [1] have long envisioned a future of learning built on AI-human collaboration, advocating for institutions to foster critical digital literacy and ethical self-awareness. Our findings from both Ukrainian and Luxembourgish participants directly echo this, as both groups consistently championed the need to embed AI ethics training within teacher education curricula. The results also align with the perspective of Alexander and Belloni [5], who argue that AI can help maintain higher education’s crucial role in human capital development, but only if institutions are willing to invest in continuous staff development, as strongly supported by Cascio [10].

However, it is necessary to stress that the reality in Ukraine complicates such an optimistic outlook. While Ukrainian participants demonstrated high digital literacy, the infrastructural fragility caused by the ongoing armed conflict in Ukraine (including frequent blackouts, especially in winter and early springtime, unreliable internet, and the need to study in bomb shelters) severely limits the actual adoption of AI. This finding supports Gagnon’s [4] warning against overestimating technological readiness in under-resourced contexts and reinforces Mahendrakar and Soundararajan’s [11] assertion that successful AI integration requires not just conceptual frameworks but also robust infrastructure.

In stark contrast, Luxembourg provides a clear example of how stable institutional support can enable structured AI experimentation and professional development. As Kreutzer and Sirrenberg [6] noted, AI can flourish when a strong institutional scaffolding is in place. Our study shows that Luxembourgish educators benefit from regular AI workshops, which resonates with Mekić et al.’s [13] emphasis on the role of AI and DevOps in modernizing education.

A shared and powerful theme across both our local findings and global scholarship is the ethical imperative of AI. Williamson and Eynon [17] caution that a lack of ethical awareness in AI can entrench bias and inequality. This is supported by Rodgers et al. [23], who proposed an AI-based ethical framework for HR processes, arguing that higher education should apply a similar level of scrutiny to student data and AI-driven decisions. For our Ukrainian participants, operating in a high-stakes, trauma-sensitive environment, these concerns were not hypothetical; they were urgent calls for algorithmic fairness and inclusion, emphasizing the global push for transparent, human-centered AI design [1, 9]. Building on these findings, we outline concrete implications for teacher preparation: ethics modules should explicitly address the principles of beneficence, non-maleficence, autonomy, justice, and explicability [22]; institutional training should align with EU-level transparency and accountability requirements [21]; and program policies should specify risk-proportionate practices for data use, model auditing, and bias mitigation.

The role of AI in fostering multilingualism and intercultural literacy [18, 19] was another critical point, one also highlighted by Miranda and Vegliante [16] and Saddhono et al. [9]. While these findings illustrate meaningful trends, they should not be interpreted as universally generalizable, given the study’s focus on two national contexts. Differences within each country’s institutions and disciplines may reveal further nuances beyond the scope of this research.

The findings revealed that both countries saw the value in AI’s capacity to support linguistic diversity, with Luxembourg embracing it as part of its multicultural policy and Ukraine seeing it as a means of preserving national identity and pedagogical continuity during wartime. This function becomes particularly nuanced when considering cultural semantics, as Mizin, Letiucha, and Petrov [34] showed in their analysis of Germanic and East Slavic linguistic differences. Their work underscores that AI translation systems might struggle with cultural and conceptual nuances, which can distort meaning. Educators must, therefore, be prepared to critically assess AI-mediated communication to ensure it maintains not only linguistic accuracy but also cultural integrity. In this context, Chaika [19] argues that generative AI, if used responsibly, can act as a crucial ally in multilingual higher education.

Finally, we found that a recurring concern was the issue of educator agency. Zawacki-Richter et al. [2] have also questioned why educators are often left out of major AI implementation decisions, supported by a concern voiced by our participants, especially in Ukraine, where systemic disruption has further marginalized teacher agency despite their frontline roles. Nelson [7] warned that AI risks displacing traditional academic identities unless institutions actively involve educators in AI strategy and design.

AI’s potential to enhance teaching is undeniable [12, 13]. However, Lamb et al. [20] argue, these changes are reshaping post-digital learning in ways we don’t fully understand yet. Our data suggests that while educators appreciate AI’s potential, they remain concerned about over-reliance and the erosion of human judgment – issues that warrant further empirical exploration, particularly in precarious environments (see Ukraine).

With the discussion in mind, the success of AI in higher education is not just about the technology itself. It depends on how institutions work through the sociopolitical, ethical, and infrastructural realities that define the experiences of educators and learners. This is where personnel development strategies become so important. Kubitskyi and Kubitsky [35] argue that effective personnel management is a strategic asset, with innovative approaches resting on modern technologies. Applied to education, this means that building AI capacity should not be seen as a mere technical update but as a crucial strategic investment in human capital. It is suggested that it can be reinforced when educators are provided with targeted training and universities can ensure long-term adaptability and resilience in the face of digital transformation, as advocated by Chaika [18, 19] and Miranda and Vegliante [16], aiming at context-sensitive, multilingual, and ethically grounded AI strategies.

This study was limited to participants in Luxembourg and Ukraine, contexts that are unique due to their linguistic diversity and, in Ukraine's case, wartime disruption. As such, the findings should be viewed as contextually grounded rather than globally representative. Future research could expand to additional countries and educational systems, employ longitudinal designs, and examine AI adoption across a wider range of disciplines.

6. Conclusion

This study investigated the complex role of AI in preparing the next generation of multicultural educators. We set out to understand how AI is perceived and integrated in two very different (as unveiled) educational environments: the stable, well-resourced system in Luxembourg and the crisis-affected context of Ukraine. Bringing together survey data and in-depth qualitative insights led to successfully addressing the core aim, objectives, and research questions, providing a clearer picture that goes beyond what simple statistics could reveal.

The quantitative findings from Ukraine showed that future educators and academic staff are highly aware of AI's potential, but this enthusiasm is paired with deep ethical concerns and a critical need for consistent professional development. Despite strong individual digital skills, only a small fraction of participants (less than 35%) reported having access to institutional AI training. As our qualitative data highlighted, this gap is dramatically worsened by the ongoing military conflict, with infrastructural issues and limited funding severely hindering AI implementation, even when the will to adopt it is strong.

Unlike in Ukraine, our analysis of the Luxembourgish context demonstrated a more proactive and stable institutional culture. Discussions with participants pointed to a system that actively promotes AI literacy and ethical use through dedicated workshops and curriculum development. This supportive environment was seen to stand in sharp contrast to Ukraine, although both countries share a fundamental goal: to effectively embed AI ethics and digital competencies into teacher education programs.

Our findings from the Luxembourg and Ukraine contexts converged on several key priorities: the necessity of ethical AI use, the importance of culturally responsive instructional design, and the indispensable role of lifelong learning. This directly answers our research questions about AI perceptions, institutional influences on adoption, and specific training needs. The study's central contribution is its comparative, empirical insight into AI integration in both a stable and a crisis-affected multicultural education system, an area that has, until now, been largely unexplored.

In summary, despite the research's contribution to the field, it is important to acknowledge its limitations, including a restricted sample size and a focus on just two national contexts, from the perspective of limitations considering broader generalizability. Future research should expand to a wider range of countries and use a longitudinal approach to track the evolving relationship between AI, educator identity, and learner outcomes over time.

Recommendations

These findings have substantial implications for policymakers and educational leaders. They advocate for prioritizing ethical AI governance, increasing institutional investment in AI literacy, and tailoring programs to diverse sociopolitical realities. It is suggested that such comprehensive strategies will empower multicultural future educators to ethically and effectively harness AI's potential, ultimately fostering equitable, inclusive, and sustainable education in an increasingly AI-mediated world.

Ethical Statement

Ethical approval was obtained from the ethics committees (that make part of faculties and the decisions are validated via Faculty Academic and Scientific Council's sitting) of the National University of Life and Environmental Sciences of Ukraine and Kryvyi Rih State Pedagogical University, covering all phases of the study including participant consent protocols. Data collected from participants in Luxembourg was conducted informally and voluntarily, outside the institutional scope of the University of Luxembourg, by the author in an adjunct academic capacity. All participants provided informed consent, and no sensitive or personally identifiable data were recorded.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Oksana Chaika: Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Serhii Kubitskyi:** Methodology, Validation, Formal analysis, Investigation, Data curation. **Natalia Berezovska-Savchuk:** Validation, Investigation, Data curation.

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