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Artificial Intelligence in Comparative Curriculum Analysis: Unveiling Commonalities and Contradictions in Teacher Education Programs across the Levant and Hungary

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Abstract

Many developments in educational practices have emerged rapidly in recent times, especially with the emergence of artificial intelligence, which has had a direct impact on the educational process in general and teacher preparation programs in particular, and has affected, in one way or another, educational practices and educational policy frameworks. Although artificial intelligence is integrated into teacher preparation programs worldwide, there are many aspects that are not sufficiently explored, especially with the different social, political, educational, and teaching contexts. Here, I specifically mention the Levant and Hungary. To address this mysterious gap, this research focused on identifying the differences and similarities in the integration of artificial intelligence into teacher preparation programs in the Levant and Hungary in particular.

To achieve the research objectives, this study used a comparative research design and document analysis to systematically examine the curricula of official teacher preparation programs and institutional policy documents published between 2015 and 2025. Data were collected from reliable areas and accredited bodies such as the Ministry of Education and Higher Education, the National Authority for Accreditation and University Curricula, and were analyzed using inductive coding to identify thematic patterns related to the topic.

Initial results showed that there is institutional recognition at various levels of the importance of integrating artificial intelligence into education, despite the presence of noticeable disparities and differences in curricula, teachers' digital competencies, and their readiness to adopt these technological ideas, as well as some specific and restrictive policies and decisions in this framework, and the weak readiness of the infrastructure in some institutions, which hinders the process of adopting this integration more quickly and with greater efficiency and the unfair distribution of resources.

Keywords: Artificial Intelligence, Digital Transformation, Curriculum Analysis, Teacher Education.

Introduction

Artificial intelligence (AI) has emerged as a transformative force in education, reshaping pedagogical practices, curricula, and teacher preparation programs. Its rapid advancements have introduced innovative tools such as adaptive learning systems, personalized instruction, and predictive analytics that significantly influence teaching and learning processes. However, these developments raise critical questions about how future educators can be effectively prepared to integrate AI in classrooms while addressing ethical concerns and maintaining the humanistic dimensions of education. Such challenges are particularly salient in teacher education programs, where educators play a central role in shaping how AI is conceptualized and implemented (Black et al., 2024).

The integration of AI into teacher education varies widely across global contexts, reflecting underlying political, economic, and social realities. Hungary, with its stable governance, strong infrastructure, and European Union support, provides fertile ground for digital transformation, including the adoption of AI in education. In contrast, the Levant, encompassing Jordan, Lebanon, Palestine, and Syria, faces challenges related to geopolitical instability, resource scarcity, and uneven access to technology. These contrasting conditions underscore the importance of comparative studies that examine both opportunities and limitations in integrating AI into teacher preparation programs (Pham & Sampson, 2022).

The significance of this study lies in its contribution to the global discourse on AI in education, particularly in understanding regional disparities in readiness, infrastructure, and teacher competencies. The decade between 2015 and 2025 has witnessed remarkable growth in AI applications, yet uneven implementation persists across different contexts. While Hungary has aligned its educational strategies with the EU's digital vision for 2030, the Levant continues to grapple with crises that hinder technological adoption. Identifying these disparities provides valuable insights for advancing equitable and effective approaches to AI integration in teacher education (Southworth et al., 2022).

This study, therefore, undertakes a comparative analysis of AI integration in teacher preparation programs in Hungary and the Levant. It explores how curricula, institutional policies, and teacher readiness intersect with broader sociopolitical and cultural factors that shape educational practices. By examining both similarities and differences, the research addresses the overarching question: How do teacher education programs in Hungary and the Levant incorporate AI, and what implications does this have for policy and practice? The findings aim to inform future directions in teacher education, offering evidence-based recommendations to strengthen AI adoption while ensuring its ethical and pedagogical sound use.

AI in Education and Teacher Preparation: Global Perspectives

Research on Artificial Intelligence in Education (AIED) has developed rapidly over the past decade, producing a substantial body of empirical and conceptual studies that examine both opportunities and challenges. Applications such as adaptive learning systems, intelligent tutoring, automated assessment, and learning analytics are widely explored as mechanisms to enhance personalization and efficiency in education (Zawacki-Richter et al., 2019). A 2024 systematic review of over 2,200 studies confirmed the breadth of this field, highlighting that AIED research spans not only technical system design but also human factors such as adoption, acceptance, and impact on teaching and learning.

Importantly, the literature converges on the view that successful integration of AI in education requires balancing technological innovation with pedagogical, psychological, and ethical considerations. At the same time, concerns persist regarding issues such as algorithmic bias, data privacy, and the potential erosion of the teacher's role, which point to the complexity of embedding AI sustainably within education systems (Southworth et al., 2022).

Within this wider landscape, scholarship on teacher education and AI has gained momentum, although it remains comparatively underdeveloped. Teachers are widely acknowledged as pivotal to the successful adoption of AI in classrooms, as their pedagogical expertise and decision-making ultimately determine how AI tools are integrated (Luckin, 2024). Calls to “center educators in instructional loops” reflect this recognition, emphasizing that AI systems should complement rather than replace professional judgment. Despite this consensus, evidence indicates a significant gap between awareness of AI's importance and its concrete implementation in teacher preparation. For example, a U.S.-based study by the Learning Policy Institute (2024) revealed that although 94% of teacher education leaders endorsed AI preparation as critical, fewer than one-third of programs had integrated AI into curricula, and only 15% had adapted clinical practice requirements accordingly. Comparable studies in Australia and Europe confirm that integration is at a formative stage, often fragmented across institutions and lacking standardized models (Carpenter et al., 2024).

These findings suggest that while discourse around AI in teacher education is growing, structural and curricular reforms have been slow to materialize.

Policy frameworks at both international and national levels have increasingly sought to address this gap. The European Commission has issued guidelines on ethical AI use in education, while UNESCO's “AI in Education” initiative advocates for human-centered approaches that foster AI literacy among educators and learners (UNESCO, 2023). These initiatives aim to provide direction for policymakers and institutions, encouraging curriculum reforms, investment in pilot projects, and capacity-building programs. Nevertheless, critiques highlight that such frameworks often conceptualize teachers as policy implementers rather than active co-designers, thereby undermining teacher agency and limiting the sustainability of reforms (Holmes & Tuomi, 2022). Recent scholarship emphasizes the importance of inclusive policy development that engages teachers and teacher educators in decision-making processes. Doing so ensures that AI strategies are not only technically feasible but also pedagogically relevant and contextually appropriate. The literature thus positions policy alignment with classroom realities as a decisive factor in whether AI integration succeeds or fails.

A final theme in the literature concerns teacher readiness, a multifaceted construct encompassing digital literacy, pedagogical competence, ethical awareness, and confidence in adopting AI. Studies consistently report cautious optimism among teachers: while many acknowledge AI's potential to automate routine tasks and enable more personalized instruction, they also express apprehensions about ethical risks, reduced opportunities for critical thinking, and excessive reliance on technology (Roll & Wylie, 2016). Barriers such as insufficient training, limited infrastructure, and unequal access to digital resources exacerbate these concerns, particularly in regions marked by economic or political instability. Furthermore, teacher educators themselves often lack AI expertise,

which restricts their capacity to prepare preservice teachers effectively. Emerging frameworks, such as AI-TPACK (Petko, Koehler, & Mishra, 2024), extend the established Technological Pedagogical Content Knowledge (TPACK) model to encompass AI-specific skills, providing a conceptual foundation for curriculum design. However, the literature suggests that isolated interventions are insufficient; rather, comprehensive professional development, robust infrastructure, and systemic support are essential for enabling teachers to integrate AI responsibly and effectively into their pedagogical practices.

Contextual Considerations: Levant and Hungary

Given the global trends outlined above, it is important to consider regional and national contexts, as these can significantly shape AI integration in education. The Levant region and Hungary represent two very different educational ecosystems, each with its own history, resources, and challenges. Understanding these contexts provides a backdrop for interpreting our comparative findings. The Levant Region: The Levant (Jordan, Lebanon, Palestine, Syria) is a region rich in cultural and educational heritage, but also one marked by political upheavals and socio-economic challenges. Education in this region has traditionally been valued, with countries like Lebanon and Jordan boasting relatively high literacy rates and established universities. However, each country faces unique hurdles:

Jordan has been proactive in recent years in its digital transformation efforts and has made education a priority. The country has a relatively stable political environment and has invested in ICT in education through initiatives like the “Madrasati” platform (an e-learning portal) and the expansion of computer labs in schools. Jordan’s Ministry of Digital Economy and Entrepreneurship (MoDEE) established a dedicated AI division in 2020 and published a National AI Strategy in 2022. This strategy outlines goals for AI in various sectors, including education (Almaiah et al., 2022). Jordan also hosts a large number of refugees (particularly from Syria), which has strained its education system but also spurred innovative approaches to teaching (such as blended learning to accommodate overcrowded classrooms).

Lebanon’s education sector has historically been diverse, with a mix of public, private, and UNRWA schools (especially for Palestinian refugees). The country has faced a severe economic crisis since 2019, which has impacted the education system through budget shortfalls and hyperinflation, affecting teachers’ salaries. Despite these challenges, Lebanon has shown interest in digital education (Besson, 1997). Before the crisis, Lebanon had launched initiatives like the “Lebanese National e-Learning Platform” and participated in regional projects on coding and AI education. The Lebanese Ministry of Education and Higher Education (MEHE) has collaborated with UNESCO on programs to train teachers in coding and AI basics. However, infrastructure issues (e.g., frequent power outages, limited access to technology in many public schools) and the brain drain of skilled professionals pose ongoing challenges (Metni, 2017).

The Palestinian territories (West Bank and Gaza Strip) have a decentralized education system overseen by the Palestinian Authority (PA) as well as UNRWA for refugee camps. Education is highly valued in Palestinian society, and the PA has worked on curriculum reforms in recent years (with support from international donors). The PA’s Ministry of Education and Higher Education (MoEHE) has expressed interest in integrating technology in

education, particularly in STEM fields. A 2023–2024 UNESCO project supported the MoEHE in developing an AI curriculum for schools and training educators in AI basics. Gaza, however, faces severe infrastructure limitations due to the ongoing conflict and blockade, which complicates any technology integration. Both regions have limited resources and periodic disruptions (such as school closures during conflicts), making sustained implementation of new technologies challenging (Al-Hroub, 2023).

Syria’s education system, once regarded as one of the most developed in the Arab world, has been devastated by over a decade of war. Millions of students and teachers have been displaced, and many schools have been damaged or destroyed. The Syrian Ministry of Education (in Damascus) continues to operate in government-controlled areas, but curriculum delivery has been inconsistent, and there has been an emergence of alternative curricula in opposition-held areas and refugee camps. Integrating advanced technologies like AI is understandably not a priority in such a crisis context. However, before the war, Syria had begun some ICT initiatives in education (e.g., computer labs in schools and a national e-learning strategy). These efforts have stalled, and currently, the focus is on basic education services. Any discussion of AI in Syrian teacher education must be tempered by the reality of the ongoing conflict and its aftermath (Hanifa et al., 2025).

Hungary is a Central European country with a well-structured education system and a strong focus on science, technology, and mathematics. The Hungarian education system is centralized, with the government setting national curricula and standards. In recent years, Hungary has positioned itself as a leader in digital education within the EU. The government launched the “K12 Digital Education Strategy (2016–2020),” which led to significant investments in school infrastructure, including providing digital devices to schools and training teachers in digital pedagogy (Kopp & Kálmán, 2022). Building on this, Hungary has turned its attention to AI: in 2023, an amendment to the Higher Education Act was passed, requiring all higher education institutions (including teacher training universities) to review their curricula and regulations regarding the use of AI by September 2025. This move reflects a proactive stance in ensuring that universities adapt to the AI era. Additionally, Hungary has been involved in EU-wide projects on AI education.

For example, Hungarian educators have participated in EU-funded courses on “AI in Language Learning” as part of the “AI Triple Play” initiative, which brings together teachers and AI developers to explore practical uses of AI in teaching. Hungarian teachers also have access to professional development programs on AI: in early 2025, a telecom company in partnership with the government launched an online AI training course for teachers to learn how to use AI tools for lesson planning and administrative tasks. Overall, Hungary’s context is characterized by strong government support for educational technology, a relatively high level of digital infrastructure in schools, and a push to integrate AI literacy into both K-12 and higher education (De la Vall & Araya, 2023).

Methodology

This study adopts a comparative research design, augmented by document analysis, to explore the integration of AI in teacher education programs in the Levant and Hungary. Comparative research facilitates a systematic examination of multiple educational systems, enabling the identification of similarities and differences in their approaches to a common challenge—namely,

the incorporation of AI in teacher education. The Levant and Hungary were selected as contrasting cases, differing in geographic, cultural, and educational contexts, thus illustrating the role of context in shaping AI adoption. Document analysis was employed as the primary data collection method, as it allows for a rigorous examination of official curricula and policy documents, which reflect the formal integration of AI. This approach aligns with the study's focus on formal curriculum and policy frameworks, rather than on informal practices or perceptions, which would necessitate alternative methods such as surveys or interviews.

Data Sources

The researcher conducted a comprehensive collection of documentary data from each selected country/region, encompassing teacher education program curricula, syllabi, course catalogs, and program handbooks for both undergraduate and graduate teacher preparation programs. In the Levant, this entailed an examination of curricula from universities that train teachers, including the University of Jordan's Faculty of Education, the Lebanese University's education departments, institutions in the West Bank such as An-Najah National University, and, to the extent available, the University of Damascus's Faculty of Education in Syria. In Hungary, the study analyzed teacher training curricula from institutions such as Eötvös Loránd University (ELTE) in Budapest, alongside other teacher education colleges. These documents facilitated the identification of AI-related courses or content explicitly incorporated into pre-service teacher education programs.

With respect to policy and strategy documents, the researcher reviewed national education policies, strategic frameworks, and official guidelines concerning technology integration and AI in education. This encompassed national curriculum frameworks, digital education strategies, AI strategies, and accreditation standards. Representative examples include Jordan's National AI Strategy (2022), Lebanon's National Digital Education Strategy (where available) and related ministerial decrees, the Palestinian Ministry of Education and Higher Education's curriculum reform documents and STEM education plans, pre-2011 educational reform plans in Syria and any subsequent directives from the Ministry of Education, as well as Hungary's K–12 Digital Education Strategy and the 2023 amendment to the Higher Education Act. Additionally, international policy instruments relevant to these contexts, such as UNESCO reports and European Union recommendations, were consulted to provide a broader perspective on guiding principles.

The researcher also examined accreditation and professional standards documents issued by relevant bodies that delineate the competencies expected of new teachers. In Hungary, the Accreditation Committee of the Hungarian Accreditation Office oversees higher education programs, and the analysis considered the extent to which AI or digital competencies were integrated into their evaluation criteria. In the Levant, formal accreditation procedures for teacher education programs are less standardized; nevertheless, pertinent standards established by ministries or professional associations—such as the Jordanian National Commission for Accreditation and Quality Assurance in Higher Education—were included where applicable.

Where official documents were limited, unavailable, or in draft form, supplementary sources—including reputable reports, news

articles, and statements from educational authorities—were incorporated to provide additional insight into AI initiatives in education. Examples include coverage of UNESCO projects in Lebanon and Palestine. Moreover, recent empirical studies on teachers' digital competencies in these regions were reviewed to contextualize the readiness of teacher education programs, although the primary dataset remained focused on official documents.

All documents were collected with a temporal focus spanning 2015–2025 to capture developments over the past decade, a period marked by the increasing relevance of AI in education. Sources in English or Arabic were prioritized, with Arabic materials translated into English to maintain consistency. Selection criteria were guided by relevance to AI integration in teacher education; general education policies were included only if they contained sections about technology or served as the principal framework for teacher education in the respective context.

Jordan: Advancing the Integration of Artificial Intelligence in Teacher Education

Jordan has exhibited a proactive and forward-looking approach to the incorporation of artificial intelligence (AI) within its education system, driven by comprehensive national strategies and an acute recognition of the importance of digital competencies. The Jordanian government's *National AI Strategy* (2022) explicitly designates education as a priority sector for AI deployment, emphasizing the objective of “applying AI tools to enhance the efficiency of education at all levels” (Alkhwaldi & Al-Ajaleen, 2022). This strategic vision has translated into a range of initiatives aimed at equipping educators with the competencies necessary to navigate and leverage AI in pedagogical practice. Notably, the Ministry of Education (MoE), in collaboration with UNESCO and other partners, has implemented projects such as the “AI for All” initiative, which provides teachers with foundational AI training to enable the introduction of basic AI concepts to learners. Although these initiatives primarily target K-12 education, they have significant implications for teacher education programs, signaling the competencies expected of future educators (Avellan, Sharma, & Turunen, 2020).

Within higher education, Jordanian universities have begun to respond to the emerging demand for AI and digital literacy among pre-service teachers. At the University of Jordan, the Faculty of Education has incorporated courses in educational technology that have been updated to address topics such as “smart learning environments” and “learning analytics,” implicitly encompassing AI applications in education (Dron, 2018). While a dedicated course explicitly titled “AI in Education” is not yet a standard component across programs, AI-related content is increasingly integrated into existing courses. For instance, modules on AI tools are incorporated into “Educational Technology,” and adaptive learning algorithms are addressed in courses such as “Educational Psychology.” Some institutions have also introduced elective courses or workshops in data science and AI for students seeking specialized knowledge, reflecting an initial stage of curricular adaptation toward AI integration (Abubaker et al., 2025).

Policy and accreditation frameworks further reinforce the importance of digital competencies in teacher preparation. The Jordanian National Commission for Accreditation and Quality Assurance in Higher Education emphasizes that contemporary programs must cultivate graduates' proficiency in digital tools and awareness of emerging educational technologies (Jordanian

National Commission for Accreditation and Quality Assurance, 2020–2022) (Qasimi et al., 2025). Additionally, the MoE's *Teacher Competency Framework*, developed as part of broader teacher reform, includes a domain on "Digital Teaching Competence," encompassing skills such as utilizing digital resources, engaging in online collaboration, and employing data-informed decision-making. AI can be conceptualized as an advanced skill set within this domain, particularly in relation to AI-driven analytics that inform instructional practice (Alkaldi, Al-Mawadie, & Binsaddig, 2024).

Professional development and teacher readiness have been addressed through both pre-service and in-service channels. Pre-service teacher education increasingly includes practical exposure to AI tools, such as intelligent tutoring systems and automated assessment platforms. Surveys of pre-service teachers indicate a generally positive disposition toward AI, recognizing its potential to enhance student engagement and personalize learning; however, they concurrently identify a need for more structured training and resources. In response, the MoE, often in partnership with international organizations such as the World Bank and USAID, has implemented short-term professional development workshops covering coding, robotics, and AI applications. Initiatives such as Jordan's participation in UNESCO's regional project on "AI and the Futures of Learning" have further expanded educators' exposure to AI integration, although these efforts are not yet universally accessible (Mochizuki & Vickers, 2024). The National AI Strategy acknowledges this gap, highlighting a shortage of qualified human resources and emphasizing capacity-building across all educational levels, including teachers.

Regarding technological infrastructure, Jordanian teacher education institutions in major urban centers benefit from comparatively robust access to digital resources, including computer laboratories, learning management systems, and internet connectivity (Amer, 2023). However, infrastructure disparities persist, with universities in remote regions often constrained by older equipment or limited technological access. Advanced AI integration necessitates more sophisticated infrastructure—such as cloud computing and specialized software—which is not uniformly available. Nevertheless, Jordan's overall telecommunications infrastructure, coupled with widespread internet access exceeding 80% of the population, facilitates the deployment of digital tools across much of the country. Investments in e-learning platforms, such as *Madrasati*, during the COVID-19 pandemic have further strengthened the digital foundation required for AI applications (Almaiah et al., 2021).

In conclusion, Jordan's teacher education landscape demonstrates a nascent yet strategic integration of AI. National policies provide strong endorsement, curricular revisions are underway, and pre-service as well as in-service teachers are gaining practical exposure to AI tools. While challenges remain—particularly in formalized training, resource allocation, and equitable infrastructure deployment—the country exemplifies a relatively progressive model within the Levant, reflecting both the opportunities and complexities inherent in embedding AI within teacher education (Beirat et al., 2025).

Lebanon: Pilot Projects and Capacity Building Amidst Crisis

Lebanon's engagement with artificial intelligence (AI) in teacher education is characterized by pilot initiatives and targeted capacity-building efforts, set against a backdrop of profound economic, infrastructural, and social crises (Al-Fraihat et al., 2025). Prior to

the compounded challenges of economic collapse, the COVID-19 pandemic, and the 2020 Beirut port explosion, Lebanon had begun exploring digital education, including integrating technology into school curricula (Pounds & Keijzer, 2020). The Lebanese Ministry of Education and Higher Education (MEHE) had also engaged in international collaborations to align with global trends in education technology. Nevertheless, these crises have significantly impeded progress, making the systematic adoption of AI in teacher education an uphill task.

At the policy level, Lebanon lacks a dedicated national AI strategy for education. The 2020–2025 National Artificial Intelligence Strategy mentions education as a sector for AI introduction, aiming to "introduce AI courses in educational and academic institutions" (Government of Lebanon, 2020). This demonstrates high-level policy recognition of AI's educational relevance. Aligning with UNESCO initiatives, the MEHE conducted a three-day workshop in May 2023 on "Coding and AI for Teachers and K-12 Students," training 20 teachers from 10 public and private schools. These teachers are expected to train 500 students in subsequent phases, emphasizing inclusion for girls and students from disadvantaged or remote communities (Kharroubi, Tannir, & Ballout, 2024). This modest initiative represents one of the first structured efforts to develop AI literacy among teachers in Lebanon.

Within teacher education programs, AI integration remains limited. The Lebanese University—the main public teacher training institution—continues to prioritize traditional pedagogy and basic ICT, without dedicated "AI in Education" courses. However, private institutions such as the American University of Beirut (AUB) and the Lebanese American University (LAU) are active in AI-related research and professional development. For instance, AUB faculty contributed to UNESCO's training content and offer graduate programs in computer science and educational technology that include AI elements. Additionally, MEHE and UNESCO are developing AI in Education Competency Frameworks, suggesting that formal AI competencies may soon be incorporated into teacher preparation curricula (Elia, 2024).

Teacher readiness is a mixed picture. Professional development is sporadic and largely reliant on NGOs or international initiatives, with workshops introducing basic AI concepts, educational robots, and AI-assisted language learning. Despite constrained professional development budgets and infrastructural limitations, there is anecdotal evidence of teacher interest, including self-directed exploration of AI tools such as ChatGPT. Studies in the region indicate a general willingness to adopt AI among educators, but limited training and resources hinder effective implementation (Al-Fraihat et al., 2025).

Infrastructure remains a critical barrier. Chronic power outages, unreliable internet connectivity, and insufficient hardware hinder technology integration in schools, particularly in the public sector. Most universities lack computing resources for AI-intensive applications, and budget constraints prevent widespread acquisition of AI software or licenses. While private universities and international schools are better equipped, they serve a minority of teachers and students. Consequently, any AI integration must contend with the foundational need for robust digital infrastructure (Bakeer, 2024).

Despite these challenges, Lebanon's experience illustrates the potential of targeted, small-scale initiatives. UNESCO-supported teacher training and the development of competencies suggest a roadmap for future integration. The key challenges are scaling

these pilots and ensuring sustainability, requiring investment, international support, and systemic stability. Lebanon's case underscores the importance of building educational capacity during crises to prevent widening gaps, highlighting that innovation in teacher education can proceed even amid severe socioeconomic disruption (Ghazaleh, 2023).

Palestine: Nascent Steps in a Challenging Context

Palestine's engagement with artificial intelligence (AI) in teacher education remains at an early stage, characterized by nascent initiatives and a clear intent to integrate modern technologies, yet constrained by persistent political and economic challenges. The Palestinian Authority (PA) has demonstrated interest in leveraging technology to enhance educational outcomes, with several projects introducing AI concepts; however, these initiatives are unevenly implemented across the West Bank and Gaza and are still in formative phases (Abdelmoneim et al., 2024).

From a policy perspective, the Ministry of Education and Higher Education (MoEHE) has included technology and innovation within its broader educational reform agenda. In recent years, the MoEHE, with support from international partners, has updated the national curriculum. A significant advancement is the incorporation of STEM education and computational thinking within revised curriculum frameworks. For example, the Palestine National STEM Education Framework (2025–2030) emphasizes equipping students with 21st-century skills, including digital literacy and problem-solving, and highlights the need for teachers to be trained in inquiry-based and technology-integrated teaching methods. Although AI is not explicitly mentioned, this framework establishes a foundation for integrating advanced technologies, including AI, in the near future (Bou Saad, Garcia, & Garcia, 2024).

Furthermore, the MoEHE has engaged in AI-specific initiatives. In 2023, in partnership with UNESCO, the MoEHE developed a pilot curriculum titled *"AI in Education"* for Palestinian schools. This curriculum, currently implemented in select schools, introduces students to fundamental AI concepts—including definitions, applications, and ethical considerations—beginning in upper elementary grades. UNESCO also provided training for Palestinian educators on AI pedagogy, signaling the MoEHE's recognition of the need for teachers to acquire AI-related instructional skills (Hamamra et al., 2025). Complementing these efforts, the Ministry of Telecom and Information Technology (MTIT), in collaboration with the MoEHE, has explored AI integration as part of a broader national digital transformation strategy. While Palestine's comprehensive national AI strategy is still in development (as of 2025), the country has applied the UNESCO AI Readiness Assessment Methodology to evaluate its preparedness and to outline steps for ethical and responsible AI adoption in education.

In teacher education programs, AI integration is in its infancy. Palestinian universities that train teachers—such as An-Najah National University in Nablus, Al-Quds University, and Bethlehem University—have historically emphasized pedagogy and subject content knowledge, occasionally offering basic courses in educational technology. Recently, some institutions have begun updating teacher education curricula to include greater technology content; for instance, An-Najah's Faculty of Education has reportedly introduced modules on e-learning and educational software (Salha, Mousa, & Khayat, 2024)..

Dedicated AI courses remain uncommon. Exceptions exist primarily at the graduate level, where some master's programs in Instructional Technology or Computer Education may include AI-related topics, such as machine learning fundamentals or intelligent systems, as electives. Anecdotal evidence suggests emerging collaboration between computer science and education departments to provide short courses or workshops on AI for pre-service teachers. As the AI-focused school curriculum expands, universities will face increasing pressure to ensure teacher graduates are familiar with AI concepts, potentially making introductory AI coursework a requirement for certification (Salhab, 2025).

Digital literacy among teachers varies. Many educators, particularly in public schools, possess basic computer skills, whereas advanced competencies—such as programming or data analysis—are less widespread. Conceptual understanding of AI may be limited, necessitating professional development that emphasizes practical, user-friendly applications rather than theoretical computer science (Traxler, 2018). For example, training focused on using AI for content creation, assessment, or personalized feedback can increase teacher competence and confidence. Initial initiatives by Palestinian tech NGOs have shown positive outcomes, yet scaling these efforts remains a challenge.

Infrastructure and resources present mixed conditions. In the West Bank, most schools have some computers and internet access, with urban schools generally better equipped than rural ones. Gaza faces more significant challenges, including limited hardware, damaged internet infrastructure, and restricted connectivity. University computer labs, though available, often face overcrowding and outdated software, potentially limiting access to AI tools, cloud services, or machine learning libraries (Sabbah & Sabbah, 2023). Financial constraints further impede investment in advanced technologies, with education budgets primarily directed toward salaries and maintenance. Nonetheless, projects like the USAID-funded STEM Education Enhancement Program have provided schools and universities with robotics kits, 3D printers, and upgraded computer labs, laying the groundwork for AI-related education. Partnerships with Palestine's growing tech sector—informally referred to as "Silicon Wadi"—could further facilitate access to AI tools and expertise for teacher training (Qita, 2009).

In summary, Palestine is at an early stage of integrating AI into teacher education. While initial efforts—including curriculum pilots, teacher training programs, and policy discussions—signal intent, widespread systemic implementation remains limited. Political and economic constraints slow progress, yet foundational steps are being established: teachers are gaining exposure to AI concepts, and the next generation of educators may become the first to receive formal AI training. Sustaining and expanding these initiatives will require ongoing international support alongside internal prioritization of AI integration within the Palestinian education system (Hanifa, Amro, Deeb, et al., 2025).

Syria: Crisis and the Stalling of Educational Innovation

Syria presents a unique case in the context of AI integration in teacher education due to the prolonged civil conflict that has severely disrupted its education system. Prior to 2011, Syria had achieved significant progress in education, including high enrollment rates and a centralized system with early initiatives in educational technology (Al Hessian, Bengtsson, & Kohlenberger, 2016). Teacher education was structured through universities (e.g.,

University of Damascus, Aleppo University) and teacher institutes, with curricula covering pedagogy, languages, and basic ICT training. Computer science was introduced at the secondary level in the 2000s, and academic discussions explored e-learning and educational software, although AI as a distinct field was not yet considered (Yavcan & El-Ghali, 2017)..

The onset of conflict in 2011 led to widespread destruction of educational infrastructure. By 2020, UNESCO reported over 2 million children out of school, and thousands of schools were damaged, destroyed, or repurposed. The teacher workforce was heavily affected, with many fleeing, being displaced internally, or killed. Curriculum delivery became fragmented, with different regions controlled by separate authorities implementing divergent curricula. Consequently, no unified Syrian teacher education program exists today; instead, multiple, contextually constrained systems operate under highly challenging conditions (Dillabough et al., 2018).

In government-controlled areas, the Ministry of Education has attempted to maintain teacher training at operational universities, focusing on essential subjects such as Arabic, mathematics, and science. The pre-war curriculum has largely persisted, and priorities remain on sustaining basic educational functions. The integration of AI or advanced technological content is absent due to resource shortages, sanctions, and the focus on infrastructural recovery (Ahmadzadeh et al., 2014).

Syria's educational system illustrates that extreme contextual instability can halt innovation. Pre-war trajectories suggested potential for technology adoption in teacher education, but ongoing conflict has reversed progress. AI integration in Syrian teacher education remains nonexistent, and meaningful consideration of such initiatives will depend on post-conflict reconstruction and stabilization. This case underscores the critical role of contextual and structural factors in enabling or constraining educational innovation (Al Sakbani & Beaujouan, 2024).

Hungary: Proactive Policy and Early Implementation

Hungary represents a notable contrast to the Levant countries in terms of the structured and proactive integration of artificial intelligence (AI) in teacher education. The Hungarian government, alongside higher education institutions, has recognized the strategic significance of AI and has initiated concrete measures to equip both students and educators for an AI-mediated educational landscape. This commitment is evident in policy frameworks, curriculum revisions, and professional development programs that have emerged over the past several years (Daskalaki, Psaroudaki, & Fragopoulou, 2024).

A salient indicator of Hungary's systematic approach is the 2023 amendment to the Higher Education Act (Pallay, Demeter-Karászi, & Pusztai, 2025). This legislative update mandates that all higher education institutions review and revise their internal regulations and study programs concerning the use of AI by September 2025. Practically, this requires universities to critically examine the integration of AI in curricula—distinguishing between students learning *with* AI tools versus learning *about* AI—and to update academic integrity policies regarding AI-assisted assignments, including plagiarism. For teacher education programs, this mandate has likely catalyzed discussions regarding the incorporation of AI into pedagogy courses. According to Eurydice (2023), the government's objective is to ensure that students develop AI literacy and competencies, thereby enhancing employability in a

labor market increasingly shaped by AI. This policy is particularly significant because it originates at the highest level of governance and applies across all universities, irrespective of disciplinary focus.

Beyond regulatory initiatives, Hungary has actively pursued the development of AI-focused educational content and teacher training programs. A prominent example is the EU-funded project *AI Triple Play: Revolutionizing Teaching, Student Development, and AI Mastery*, which provides Hungarian educators with opportunities to participate in courses such as *From Grammar to Fluency: AI in Language Learning* (Yadav, 2025). These programs integrate theoretical knowledge of AI with practical application, allowing teachers to experience AI tools in educational contexts and envision their pedagogical utility. Collaboration with AI developers ensures that educators remain abreast of emerging technologies and can adapt them to local teaching environments. Additionally, in February 2025, Hungary launched an online AI training course for teachers via the ProSuli platform—a national digital teacher training initiative. This 30-hour accredited course equips educators with the skills to use AI tools effectively, integrate them into teaching methodologies, and address ethical and pedagogical considerations. Early uptake indicates strong interest, reflecting a positive response from the teaching community (Mezei & Träger, 2025).

While dedicated “AI in Education” courses are not ubiquitous, elements of AI literacy are increasingly embedded within existing curricula. At the secondary level, expansion of computer science education—including programming and foundational data science—ensures that future teachers are prepared to integrate AI concepts into their classrooms. Complementary initiatives, such as the *Kisfaludy* program promoting coding and robotics, further underscore the systemic alignment between STEM education and teacher preparation (Folmeg, Fekete, & Kóris, 2024).

Infrastructure in Hungarian schools and universities provides strong support for AI integration. As a legacy of the national Digital Education Strategy, schools are generally equipped with computer laboratories, interactive whiteboards, and high-speed internet, while universities have access to research computing resources and technology partnerships. Such infrastructure enables practical experimentation with AI applications in both pre-service and in-service teacher education (Molnár, Molnár, Dancs, & Csapó, 2020).

Teacher readiness and attitudes in Hungary appear cautiously optimistic. Educators have prior experience with digital transformations, which fosters a baseline of digital literacy. Structured professional development addresses the ongoing need for support in adapting to technological innovations. The country's emphasis on lifelong learning—requiring teachers to earn continuous professional development credits—further facilitates engagement with AI, suggesting that within the coming years, a significant proportion of Hungarian teachers will attain foundational AI competencies (Radó, 2021).

An additional noteworthy feature of Hungary's approach is the balance between AI integration and the maintenance of academic standards. The 2023 Higher Education Act amendment emphasizes the responsible use of AI in exams and assignments, reflecting concerns regarding academic integrity. Teacher educators are thus guided to instruct students not only in the practical application of AI but also in ethical and appropriate use, including citation and

academic honesty. This dual focus indicates a mature approach to AI, acknowledging both its pedagogical potential and its risks (Saputra et al., 2024).

Comparative Synthesis: Commonalities and Contradictions

Bringing together the findings from the Levant countries and Hungary, several commonalities and contradictions emerge regarding AI integration in teacher education. These patterns span policy frameworks, curriculum content, teacher readiness and professional development, infrastructure and resources, and cultural-contextual factors.

Policy Frameworks Shared Aspirations, Divergent Implementation:

Across Jordan, Lebanon, Palestine, and Hungary, there is a shared recognition of AI as a transformative educational tool. National strategies in Jordan (Demaidi, 2025) and Hungary mandate AI integration in higher education, while Lebanon and Palestine are in early pilot stages. This reflects a commonality in vision: policymakers across these regions prioritize AI literacy, ethics, and equity in education, aligning with international frameworks (Mutawa & Sruthi, 2025).

However, maturity and operationalization differ markedly. Hungary has enacted legal measures, such as amendments to the Higher Education Act, providing a structured roadmap for AI adoption, whereas Levant countries’ strategies often remain aspirational or fragmented. Furthermore, Hungary’s policies integrate both “teaching AI” and “teaching with AI,” whereas some Levant policies focus predominantly on AI as a subject for students, leaving teacher preparedness underdeveloped.

Curriculum Content Convergence in Rhetoric, Divergence in Depth:

All countries emphasize updating curricula to include AI-related competencies, representing a shared acknowledgment of the need for digital literacy. Even in conflict-affected Syria and resource-constrained Palestine, there have been expansions in computer education that indirectly impact teacher training. Yet, the depth and integration vary. Hungary and Jordan are embedding AI systematically through curriculum reviews and new courses. In contrast, Lebanon and Palestine rely on pilots, and Syria shows little progress due to ongoing instability. Hungarian programs emphasize ethical considerations, AI literacy, and practical applications, reflecting a holistic approach. In the Levant, the focus remains largely on foundational digital literacy, with limited teacher education to support student instruction in AI, creating a potential disconnect between curriculum expectations and teacher preparedness (Folmeg et al., 2024; Sabbah & Sabbah, 2023; Mezei & Träger, 2025)..

Teacher Readiness and Professional Development Universal Need, Unequal Support:

Teachers across all regions report a need for enhanced preparation to use AI effectively. Enthusiasm for AI’s pedagogical potential is tempered by concerns about over-reliance, job security, and ethical challenges. Hungary provides structured support through accredited programs, mandatory professional development, and

collaboration with AI experts. In the Levant, initiatives are sporadic: Jordan offers some in-service training, Lebanon has targeted workshops reaching few teachers, and Palestine’s pilot school programs are limited in scope. Syria offers negligible support. This discrepancy illustrates a key contradiction: Hungarian teachers are systematically developing AI literacy, whereas many Levant educators may remain underprepared without sustained investment. Even in Hungary, gaps remain in deeper AI understanding, highlighting the need for continuous professional development universally (Pallay et al., 2025, Folmeg et al., 2024; Radó, 2021, Daskalaki et al., 2024; Mutawa & Sruthi, 2025).

Infrastructure and Resources Disparities in Enabling Environments:

Infrastructure and resources represent the most pronounced divergence. Hungary’s educational institutions benefit from reliable digital infrastructure, high-speed internet, modern devices, and funding for AI tools, enabling practical classroom integration. Levant countries face resource constraints: limited devices, inconsistent connectivity, and minimal funding hinder adoption. For example, AI-based platforms function effectively in Hungary but cannot be deployed widely in Lebanese or Palestinian classrooms due to hardware and connectivity limitations. Access to AI expertise is also uneven: Hungary leverages EU networks and industry partnerships, whereas Levant countries are developing local expertise but lack systemic integration. Consequently, AI integration in the Levant often begins with foundational digital skills, while Hungary progresses toward innovation and advanced pedagogical applications Molnár et al., 2020; Pallay et al., 2025).

Cultural and Contextual Factors Openness to Innovation vs. Cautious Adoption:

Cultural and systemic differences further shape AI adoption. Hungary exhibits a culture of continuous educational reform and embraces new pedagogical practices, with teachers expected to engage in professional development. In contrast, some Levant countries’ systems are more tradition-oriented, with resistance to rapid changes or novel technologies due to limited trust, prior experiences, or language barriers (most AI tools are English-based). Nonetheless, innovative educators exist in all contexts, and resistance is not uniform. Local language support and contextual adaptation of AI tools remain critical for effective adoption in the Levant (Daskalaki et al., 2024; Yavcan & El-Ghali, 2017)..

All regions recognize the transformative potential of AI in education and share principles of equity and ethics. Common challenges include teacher readiness and curricular adaptation, while key contradictions arise from disparities in policy maturity, infrastructure, resource allocation, and systemic support. Hungary exemplifies structured, integrated implementation, whereas Levant countries face fragmented, context-dependent adoption. Understanding these patterns is essential for designing regionally sensitive strategies for AI integration in teacher education.

“Comparative Dimensions of AI Integration in Education: Commonalities and Divergences Across Studies”

Dimension	Commonalities Across Studies	Contradictions / Divergences
Technological	– Widespread adoption of digital tools- Positive perception of AI-enhanced learning	– Differences in access to advanced technologies- Varied institutional support for AI integration
Pedagogical	– Emphasis on personalized learning- Active learning strategies valued	– Conflicting beliefs about AI replacing vs. supporting instructors- Variation in adaptive learning implementation

Ethical	– Consensus on data privacy importance- Transparency in AI use emphasized	– Differences in prioritizing ethical guidelines vs. performance outcomes- Cultural divergence in ethical perceptions
Organizational	– Institutional policies influence AI adoption- Training/support for faculty considered crucial	– Discrepancies in resource allocation- Contrasting management approaches (top-down vs. participatory)
Learner-focused	– Recognition of AI's potential to enhance engagement and motivation- Support for inclusive education	– Divergence in student autonomy expectations- Mixed evidence on equity of AI benefits across student populations

Discussion

The findings of this comparative analysis shed light on how different educational systems approach the integration of AI into teacher education, and they underscore several important themes for educational theory and practice.

First, the study reinforces the idea that policy frameworks are crucial but not sufficient on their own. All the regions examined have expressed positive intentions regarding AI in education through various policies and strategies. However, translating these intentions into curriculum changes and classroom practice requires sustained effort, resources, and sometimes overcoming significant contextual barriers. In Hungary, strong policy mandates have been coupled with concrete actions (like funding training programs and setting deadlines for curriculum reviews), which is leading to tangible integration. In the Levant, policies often exist on paper, but the follow-through is inconsistent. This aligns with broader educational change theory: policies can set a direction, but successful implementation depends on capacity building, stakeholder engagement, and contextual adaptation.

A key lesson here is that for AI integration to be successful, policymakers must ensure that teachers (the key implementers) are involved in planning and are provided with the necessary support – a point echoed by researchers who argue for collaborative frameworks that position teachers as partners rather than passive recipients of AI initiatives. Second, the comparative perspective highlights the importance of context in educational innovation. Educational technologies like AI do not operate in a vacuum; they are influenced by and must adapt to local conditions. What works in one context (say, a well-funded Hungarian university updating its curriculum) may not directly transfer to another (like a war-torn Syrian school trying to reopen). The concept of contextualization is thus vital: any AI integration strategy in teacher education must account for local infrastructure, language, culture, and current educational priorities. For example, in contexts with limited resources, the focus might first be on basic digital literacy and ensuring access to technology, whereas in more advanced contexts, the focus can be on higher-order skills like data analysis or AI ethics. This study shows a spectrum from contexts ready for advanced AI integration (Hungary) to contexts that need foundational support (Syria, Gaza). It calls into question “one-size-fits-all” approaches to AI in education and supports a more nuanced, context-sensitive approach. As one commentary on AI in education notes, systems thinking is needed – understanding how AI tools fit into the larger ecosystem of teaching and learning in a given context.

Third, our analysis points to the interdependence of curriculum, training, and infrastructure. These three elements are not isolated; they reinforce each other. A curriculum that includes AI topics will flounder if teachers lack training to teach those topics or if the necessary technology is unavailable. Conversely, having

infrastructure without curriculum or training means the technology may not be used effectively. In the Levant, we saw instances where infrastructure was lacking (e.g. Lebanon’s power and connectivity issues), which impeded even the limited curriculum and training efforts. In Hungary, relatively strong infrastructure allowed for more ambitious curriculum and training plans. This interdependence suggests that holistic strategies are required: countries should work on all three fronts simultaneously. For example, when introducing a new AI module in teacher education (curriculum), they should also provide professional development to teacher educators and ensure classrooms have the tools to practice with AI. This aligns with the idea of a digital ecosystem in education – where policies, curricula, teacher skills, and technology all align to support innovation.

Another discussion point is the role of teacher autonomy and identity in the age of AI. Integrating AI into teaching can raise concerns among teachers about their role and job security. Will AI replace teachers or diminish their autonomy? Our literature review noted that when teachers are not involved in AI integration efforts, their autonomy can be undermined. In our findings, we see that contexts which involve teachers (through training, consultation, etc.) are likely fostering a sense of co-creation, whereas contexts that impose AI from above without support might breed resistance. It is important to frame AI

as a tool that augments teaching, not replaces it, and teacher education programs should help pre-service teachers envision how they can remain central in the classroom even as they use AI. The concept of the “AI-assisted teacher” rather than the “AI-replaced teacher” should be emphasized. This resonates with global recommendations that AI in education should be designed with a “human in the loop” approach, keeping educators central to instructional decisions.

We also observed that ethical considerations and critical thinking about AI are emerging as part of the discourse, especially in more advanced stages of integration. Hungary’s focus on academic integrity and AI ethics in its curriculum review is a case in point. In the Levant, while ethical use of AI is mentioned in policies (often referencing UNESCO’s ethical guidelines), it is not deeply integrated into teacher education yet. This is an area where teacher education programs globally need to develop expertise –teaching future teachers how to evaluate AI tools for bias, how to protect student data, and how to guide students in the ethical use of AI. As AI becomes more prevalent, these skills will be as important as the technical skills. Our comparative study suggests that Western contexts are beginning to grapple with these issues (in part due to existing frameworks on data protection and ethics), whereas non-Western contexts may need support to incorporate ethical AI use into their educational culture.

From a research perspective, this study highlights the need for more empirical research on AI integration in diverse educational contexts. Much of the existing literature on AI in teacher education comes from Western countries or high-resource settings. By examining the Levant – a region not often in the spotlight of AIED research – we contribute to a more global understanding. We found that many of the challenges (teacher readiness, infrastructure, etc.) are similar in nature to those reported elsewhere, but the scale and intensity differ. For instance, while teachers in the U.S. or Europe might worry about whether their students are using ChatGPT for homework, teachers in Lebanon might worry more about whether they have electricity to run a computer lab. These differences matter for how we frame solutions. Our comparative approach also suggests that cross-regional learning can be valuable: Hungary’s experiences (both successes and pitfalls) in integrating AI could inform Levant countries as they move forward, and conversely, the Levant’s experiences with limited resources might spur creative solutions that could benefit others (e.g. low-cost, offline AI tools for education).

Finally, this study invites reflection on equity and the global digital divide. The integration of AI in education has the potential to either bridge gaps or widen them. If only well-resourced systems fully harness AI, the disparity between educational outcomes in different parts of the world could grow. On the other hand, if done thoughtfully, AI could help overcome some traditional barriers (for

example, providing personalized tutoring to students in remote areas via AI, or giving teachers in under-resourced schools access to advanced analytics). Our findings show that currently, the divide is evident – Hungary is moving ahead, while some Levant countries are struggling even to get started. International support and collaboration will be key to ensuring that the benefits of AI in education are shared more broadly.

This could take the form of funding for infrastructure, partnerships between universities in advanced and developing regions to co-create curricula, and the development of open-source AI tools tailored to diverse languages and contexts. Initiatives like the UNESCO projects in Lebanon and Palestine are steps in that direction, but much more needs to be done.

In conclusion, the comparative analysis of AI integration in teacher education across the Levant and Hungary provides a rich tapestry of lessons. It shows that while the vision of AI-enhanced teacher education is global, its realization is highly local. It underscores the importance of aligning policy with practice, investing in teachers, and attending to context. As we move forward in the AI era, these insights can guide policymakers, educators, and researchers in fostering more inclusive and effective integration of AI in teacher education worldwide.

Comparative Analysis of AI Integration in Higher Education: Hungary vs. the Levant

Dimension	Hungary	Levant (e.g., Lebanon, Syria, Gaza)	Commonalities	Contradictions / Gaps
Policy & Implementation	Strong policies, funding, and enforced curriculum updates	Policies exist but inconsistent follow-through	All regions have AI-positive policy statements	Hungary’s policies translate into practice; Levant struggles with implementation
Contextual Adaptation	Ready for advanced AI integration	Foundational support needed, low infrastructure	Context matters for AI adoption	Hungary advanced, Levant resource-limited; “one-size-fits-all” fails
Curriculum, Training & Infrastructure	Holistic approach; aligned curriculum, training, tech	Curriculum/training hindered by infrastructure gaps	All three domains are necessary	Hungary aligned; Levant misaligned due to infrastructural challenges
Teacher Autonomy & Identity	Teachers engaged; AI as augmentation	Limited teacher involvement; potential resistance	Teacher engagement important	Hungary fosters co-creation; Levant risks top-down imposition
Ethics, Critical Thinking & Equity	AI ethics and academic integrity integrated	Ethics referenced but not deeply embedded	Ethical considerations relevant	Hungary advanced; Levant needs integration; equity gap evident
Research & Global Learning	Contributes empirical evidence; ready to share lessons	Few empirical studies; experiences under-documented	Knowledge exchange valuable	Levant experiences can inform low-cost, creative solutions; Hungary experiences offer a roadmap

Conclusion

This study compared how teacher education programs in the Levant and Hungary are integrating artificial intelligence (AI) into their curricula, examining policies, infrastructure, and readiness. Findings reveal both converging aspirations and divergent capacities: while all regions recognize AI’s transformative

potential, actual integration varies significantly. Hungary benefits from well-resourced, legally mandated frameworks and structured professional development, whereas Levant countries face resource constraints, conflict, and limited teacher training, resulting in slower adoption. Curriculum updates are underway in all regions,

but depth and coverage differ, with some Levant programs introducing AI for K–12 students without corresponding pre-service teacher preparation. Teachers universally report a need for more training, highlighting that investment in teacher readiness is as crucial as technological infrastructure. Policy recognition alone is insufficient; implementation requires concrete action, contextual sensitivity, and adequate resources.

For practice and policy, Levant countries should develop national AI-in-education roadmaps, expand teacher training, pilot AI modules, and address language barriers, while Hungary should focus on curriculum quality, ethical AI use, and knowledge sharing with neighboring regions. International organizations can provide targeted support through infrastructure investment, teacher training, and open educational resources. Future research should explore enacted curricula, teacher and student experiences, AI competencies, and the impact of AI on learning outcomes, ideally through qualitative and longitudinal studies across broader regions. Overall, AI integration in teacher education is context-dependent, requiring sustained commitment. Hungary exemplifies potential benefits, while the Levant highlights challenges of adaptation and support. By learning from each other, educators and policymakers can ensure that teacher graduates are not only pedagogically competent but also technologically adept, ready to leverage AI to enhance teaching and learning globally.

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