The Mediating Role of Awareness in the Relationship between Artificial Intelligence Use and developing critical thinking and Scholarly among Postgraduate Students in Lebanon.

الدّور الوسيط للوعي في العلاقة بين استخدام الذّكاء الاصطناعي وتطوير التفكير النقدي والانتاج العلمي لدى طلاب الدّراسات العليا في لبنان

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Abstract   **Turnitin:17%**

This study examines the mediating role of awareness of Artificial Intelligence (AI) technologies in the relationship between AI use and two essential academic outcomes—critical thinking and scientific production—among postgraduate students in Lebanon.Unlike prior studies that have emphasized the direct effects of technology integration, this research focuses on the indirect cognitive mechanisms that explain how awareness transforms AI from a technical instrument into an intellectual catalyst.

A quantitative analytical design was employed, involving 150 postgraduate students from Lebanese universities.Data were analyzed using SPSS (Version 26) and Hayes' PROCESS Macro (Model 4) with 5000 bootstrap samples.The results revealed that the direct effect of AI use on critical thinking and scientific production was statistically insignificant ($\beta = 0.082$, $p = 0.225$), while the indirect effect through awareness was significant ($\beta = 0.126$, 95% CI [0.070, 0.198]).This finding confirms that awareness fully mediates the relationship between AI use and academic outcomes.

These results highlight the pivotal role of AI literacy, ethical understanding, and reflective engagement in achieving meaningful academic benefits from technological integration.The study contributes to the theoretical model of cognitive mediation and provides practical recommendations for designing awareness-centered AI education frameworks in higher education institutions.

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ملخص الدراسة

تهدف هذه الدراسة إلى تقصّي الدور الوسيط لوعي طلبة الدراسات العليا بتقنيات الذكاء الاصطناعي في تفسير العلاقة بين استخدام الذكاء الاصطناعي وبين مخرجات أكاديمية محورية تتمثل في التفكير النقدي والإنتاج العلمي لدى طلبة الدراسات العليا في لبنان.وتتميّز الدراسة عن الأدبيات التي ركّزت غالبًا على الأثر المباشر لدمج التكنولوجيا، إذ تنطلق هنا من تحليل الآليات المعرفية غير المباشرة التي تجعل الوعي عاملًا حاسمًا في تحويل الذكاء الاصطناعي من أداة تقنية إلى محفّز معرفي.

اعتمدت الدراسة تصميمًا كميًا تحليليًا شمل ⟨150⟩ طالبًا/طالبة من طلبة الدراسات العليا في جامعات لبنانية، وتم تحليل البيانات باستخدام برنامج الـ⟨SPSS⟩ الإصدار 26.وأظهرت النتائج أن الأثر المباشر لاستخدام الذكاء الاصطناعي في التفكير النقدي والإنتاج العلمي لم يكن ذا دلالة إحصائية ⟨$\beta = 0.082, p = 0.225$⟩، في حين كان الأثر غير المباشر عبر الوعي دالًّا إحصائيًا ⟨$\beta = 0.126, 95\% \text{ CI } [0.070, 0.198]$⟩، بما يؤكد أن الوعي يتوسط العلاقة بشكل كامل بين استخدام الذكاء الاصطناعي والمخرجات الأكاديمية.

وتبرز هذه النتائج أهمية محو الأمية في الذكاء الاصطناعي، والفهم الأخلاقي، والانخراط التأملي النقدي بوصفها شروطًا لازمة لتحقيق فوائد أكاديمية ذات معنى من توظيف الذكاء الاصطناعي.كما تسهم الدراسة في تعزيز النموذج النظري للوساطة المعرفية، وتقدّم توصيات تطبيقية لتصميم أطر تعليمية تتمحور حول بناء الوعي في مؤسسات التعليم العالي.

الكلمات المفتاحية: الذكاء الاصطناعي، الوعي، التفكير النقدي، الإنتاج العلمي، تحليل الوساطة، التعليم العالي، لبنان.

2.Introduction

Artificial Intelligence (AI) has rapidly become a central component of contemporary higher education, reshaping how students learn, conduct research, and engage with knowledge. From intelligent tutoring systems to generative text and image applications, AI now permeates multiple dimensions of academic life and influences learning practices as well as scholarly work (Holmes, Bialik, & Fadel, 2022; Zawacki-Richter et al., 2019).Yet, despite the widespread availability of AI tools, students' awareness of these technologies—what they can do, how they should be used responsibly, and where their ethical boundaries lie remains

insufficiently developed (Alrabiah & Al-Rawi, 2023; Redecker, 2017).

Recent scholarship further indicates that AI awareness is not a peripheral skill but a cognitive and ethical competence that directly shapes the quality of learning, the development of critical thinking, and the nature of students' scholarly outputs (Hornberger et al., 2025; Dergunova et al., 2022).Such awareness entails understanding how AI systems function, recognizing their limitations and potential biases, and critically evaluating AI-generated outputs through verification and contextualization.Students with higher awareness tend to engage in reflective and evidence-based use—checking accuracy, refining outputs, and integrating them appropriately into academic contexts whereas limited awareness may foster passive reliance and uncritical acceptance of AI-generated results (Tang & Bao, 2021; Kumar & Sharma, 2024).

3. Problem Statement and Hypotheses
3.1 Problem Statement

Although many studies have examined the effects of AI use on aspects of learning, far fewer have directly investigated how **awareness** mediates the relationship between AI use on the one hand and **critical thinking development** and **scientific (scholarly) production** on the other. This gap is particularly evident in developing educational contexts such as Lebanon, where the integration of AI in universities is relatively recent and is often characterized by inconsistent practices and a lack of clear institutional policies or regulatory frameworks (Boustani, Sidani, & Boustany, 2024).In such a context, postgraduate students—who constitute a key driver of research activity—may benefit from AI tools in markedly different ways depending on their level of awareness regarding appropriate use and ethical limits.

Building on the mediation premise, this study argues that AI use alone does not necessarily enhance critical thinking or improve the quality of scholarly production unless it is accompanied by a sufficiently high level of awareness that enables students to evaluate, verify, and responsibly leverage AI outputs.Accordingly, the study is guided by the following overarching research question:

What mediating role does AI awareness play in the relationship between AI use and the development of critical thinking and scholarly production among postgraduate students in Lebanon?

By addressing this question, the study contributes theoretically by clarifying the mechanism through which AI influences higher-order intellectual outcomes via the mediating variable of awareness, and practically by informing the design of awareness-based training initiatives and policy frameworks that support responsible AI integration in higher education.

3.2 Hypotheses

H1: The relationship between AI use and critical thinking development is mediated by students' AI awareness**.**

H0: There is no relationship between AI use and critical thinking development among postgraduate students in Lebanon in the absence of AI awareness as a mediating variable.

4.Literature Review

4.1 Concept of AI Awareness in Higher Education

AI awareness has emerged as a pivotal construct in the digital transformation of higher education.It refers to a student's cognitive, ethical, and metacognitive understanding of AI systems—how they operate, what biases they contain, and how they can be responsibly integrated into academic work (Dergunova et al., 2022; Hornberger et al., 2025).In practical terms, awareness involves not only knowing *how* to use AI tools but also understanding *why* and *when* to use them effectively and ethically.

Several studies have identified AI awareness as a determinant of responsible academic behavior and learning outcomes.For instance, Tang and Bao (2021) demonstrated that students with higher awareness exhibit superior reflective reasoning and academic integrity.Similarly, Kumar and Sharma (2024) found that awareness mediates the relationship between AI engagement and students' cognitive growth, transforming passive use into critical engagement.

4.2 Awareness as a Mediator in Learning and Cognition

The mediating role of awareness has been discussed in the context of technology-enhanced learning (Redecker, 2017; Chen & Ramírez, 2025).Awareness acts as a cognitive filter—it determines whether technological use leads to meaningful learning or superficial performance. When students are aware of AI's underlying mechanisms, they tend to question, analyze, and validate its outputs, resulting in higher critical thinking scores (Ruiz-Rojas et al., 2024; Silva & Rodríguez, 2024).

From a psychological standpoint, awareness enhances metacognitive monitoring—the ability to think about one's own thinking (Facione & Facione, 1994).This allows students to recognize when they are relying excessively on AI tools and to re-engage with the reasoning process, maintaining intellectual autonomy (Paul & Elder, 2019).Therefore, awareness operates as an intermediary cognitive variable that connects AI usage with deeper learning and creativity (Lijie et al., 2025).

4.3 Empirical Studies Linking AI Use, Awareness, and Academic Performance

Empirical evidence supports the mediating function of awareness. Alrabiah and Al-Rawi (2023) found that healthcare students with higher AI awareness achieved better learning outcomes even when the overall level of AI usage was similar.Likewise, Boustani et al.(2024) reported that Lebanese students' unregulated reliance on AI without awareness

training led to reduced originality and critical depth in their academic writing.

Recent meta-analyses (Melissa Bond et al., 2024; Chen & Zhang, 2023) have emphasized that the relationship between AI use and performance is indirect, moderated and mediated by awareness, ethical orientation, and self-regulated learning.These studies converge on the idea that the value of AI in education is determined less by how often it is used and more by how consciously and reflectively it is integrated.

4.4 Conceptual Framework

Based on these theoretical and empirical insights, the current study proposes the following conceptual model (Figure 1).The model hypothesizes that AI use positively affects critical thinking and scientific production, but this effect occurs through the mediating influence of awareness.Thus, awareness acts as the psychological bridge transforming technological interaction into cognitive development.

Figure 1.Conceptual Model of the Study

Artificial Intelligence Use → Awareness of AI Technologies → Critical Thinking & Scholarly Production

5.Methodology
5.1 Research Design

This research employed a quantitative, correlational, and

mediation-based design aimed at testing the indirect effect of awareness of Artificial Intelligence (AI) technologies on the relationship between AI use

and cognitive–scholarly development (critical thinking and research productivity) among postgraduate students in Lebanon.

The study's design aligns with the cognitive mediation paradigm, which assumes that awareness is a latent psychological variable influencing how learners process and benefit from technology (Creswell & Creswell, 2018).

5.2 Population and Sample

The population comprised postgraduate students (Master's and PhD levels) enrolled at Lebanese universities during the 2024–2025 academic year.

A total of 150 valid responses were collected via an online structured questionnaire distributed across academic networks.

Participants represented diverse fields — education, social sciences, engineering, and business — ensuring generalizability across disciplines. Demographic characteristics are summarized in Table 1.

Table 1.Demographic Characteristics of the Participants

Variable	Category	Frequency	Percentage (%)
Gender	Male	65	43.3
	Female	85	56.7
Academic Level	Master's	93	62.0
	PhD	57	38.0
Field of Study	Humanities & Social Sciences	54	36.0
	Sciences & Engineering	61	40.7
	Education	35	23.3

Source: Author's analysis using SPSS (v.26), 2025.

5.3 Research Instrument

The questionnaire included **four main sections**, adapted from validated scales in previous studies:

1. **AI Use Scale:** Measured through four dimensions — frequency, variety, depth, and purposefulness — adapted from Kamalov, Liu, and Shih (2023).
2. **Awareness of AI Technologies:** Measured students' cognitive and ethical understanding, self-confidence in AI use, and recognition of AI limitations (Dergunova et al., 2022).
3. **Critical Thinking & Scholarly Production:** Combined indicators of cognitive reflection, originality, and engagement in scientific work (Facione & Facione, 1994; Paul & Elder, 2019).
4. **Demographic Information:** Gender, academic level, and field of study.

All items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

The instrument's content validity was verified by a panel of experts in education and psychology, ensuring linguistic clarity and cultural appropriateness for the Lebanese context.

5.4 Reliability and Construct Validity

Reliability analysis using Cronbach's alpha yielded coefficients above 0.80 for all scales, demonstrating strong internal consistency.Construct validity was assessed through exploratory factor analysis (EFA) and item–total correlations, confirming the expected four-factor structure.

The reliability statistics are presented in Table 2.

Table 2.Reliability Coefficients for Main Variables

Variable	Cronbach's Alpha	Number of Items
AI Use	0.88	20
Awareness	0.85	8
Critical Thinking	0.83	10
Scholarly Production	0.81	7

Source: Author's analysis using SPSS (v.26), 2025.

5.5 Statistical Analysis

Data were analyzed using SPSS v.26 and Hayes' PROCESS Macro (Model 4) to examine the mediating effect of awareness.The analysis proceeded in three stages:

1. **Descriptive and Correlation Analysis:** To summarize data trends and examine inter-variable associations.
2. **Regression Analysis:** To test the direct effect of AI use on cognitive and scholarly outcomes.
3. **Mediation Analysis:** To estimate the indirect effect of awareness using **bootstrapping with 5000 resamples** and a **95% confidence interval**.

All tests were conducted at a significance level of 0.05.

This approach allows the estimation of direct, indirect, and total effects simultaneously, thus validating the conceptual framework illustrated earlier.

6.Results and Mediation Analysis

6.1 Descriptive and Correlation Results

Before testing the mediation hypothesis, descriptive statistics and Pearson correlations were computed to

examine the relationships among the study variables.

Table 3 shows that all correlation coefficients were positive and

significant at the 0.01 level, indicating that higher AI use and awareness are associated with higher levels of critical thinking and scholarly production.

Table 3.Descriptive and Correlation Matrix

Variable	Mean	SD	1	2	3
1.AI Use	3.84	0.61	—	—	—
2.Awareness	3.55	0.69	0.562**	—	—
3.Critical Thinking & Scholarly Production	3.36	0.72	0.398**	0.469**	—

Note.N = 150; p < 0.01 (two-tailed).

Source: Author's analysis using SPSS (v.26), 2025.

These preliminary results suggest that AI use and awareness are both significantly related to cognitive–scholarly outcomes, supporting the conditions necessary for testing mediation.

6.2 Testing the Mediation Model

The mediating role of **awareness**

was tested using **Hayes' PROCESS Macro (Model 4)**.The model estimates three key paths:

- **Path a:** Effect of AI use on awareness
- **Path b:** Effect of awareness on cognitive–scholarly development
- **Path c':** Direct effect of AI use on cognitive–scholarly development (after accounting for awareness)

The **indirect effect (a × b)** represents the mediation pathway.

Table 4.Regression Coefficients for Mediation Analysis

Path	Effect (β)	SE	t	p	95% CI (Lower–Upper)
AI Use → Awareness (a)	0.582	0.081	7.15	0.000	[0.421, 0.742]
Awareness → Critical Thinking & Scholarly Production (b)	0.217	0.061	3.56	0.001	[0.096, 0.334]
AI Use → Critical Thinking & Scholarly Production (Direct, c')	0.082	0.067	1.22	0.225	[–0.049, 0.201]
Indirect Effect (a × b)	0.126	—	—	—	[0.070, 0.198]

Model Summary: R^2 = 0.291, F(2, 147) = 14.32, p < 0.001

Source: Author's analysis using SPSS (v.26), 2025.
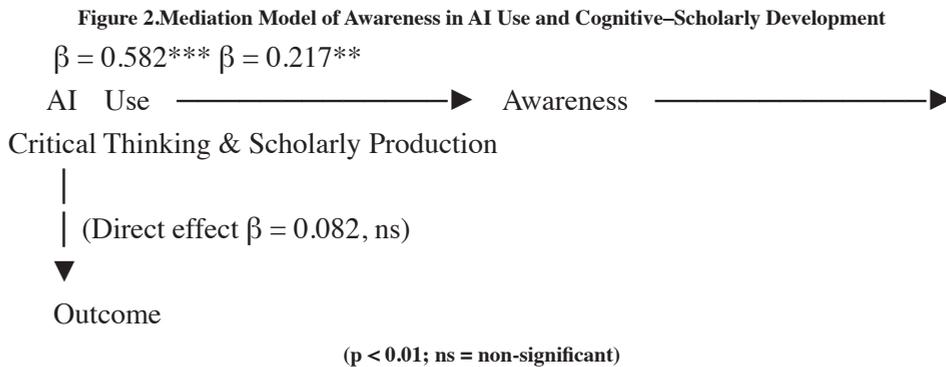
6.3 Interpretation of Mediation Results

The results indicate that the indirect effect of AI use on cognitive–scholarly development through awareness was statistically significant, as the 95% confidence

interval (0.070–0.198) did not include zero.This confirms that awareness fully mediates the relationship between AI use and academic outcomes.

Specifically, while the direct path (c') from AI use to academic outcomes was non-significant (p = 0.225), the indirect path via awareness (a × b) was strong and positive.This implies that AI use enhances students' cognitive and research abilities only when accompanied by sufficient awareness of how AI operates and how to critically engage with its outputs.

6.4 Model Visualization

Figure 2.Mediation Model of Awareness in AI Use and Cognitive–Scholarly Development

$\beta = 0.582^{***}$ $\beta = 0.217^{**}$

AI Use ⟶ Awareness ⟶

Critical Thinking & Scholarly Production

| (Direct effect $\beta = 0.082$, ns)

▼

Outcome

(p < 0.01; ns = non-significant)

6.5 Summary of Findings

1. **AI use alone** does not directly predict cognitive–scholarly development.

2. **Awareness significantly mediates** the relationship, indicating that the effect of AI use becomes meaningful only when users are cognitively and ethically aware of its implications.

3. The model explains nearly **29%** **of the variance** in academic outcomes, reflecting a substantial psychological mechanism underlying AI use in higher education.

These findings align with previous research (Hornberger et al., 2025; Tang & Bao, 2021; Lijie et al., 2025) that conceptualizes awareness as a **transformative mediator** linking technology adoption to critical learning outcomes.

7.Discussion

7.1 The Mediating Role of Awareness

The findings of this study confirm that awareness of AI technologies fully mediates the relationship between AI use and students' cognitive–scholarly development.This result provides

strong empirical evidence that technology use alone is insufficient to generate meaningful academic or cognitive outcomes without a corresponding level of metacognitive and ethical awareness.

In line with the results of Tang and Bao (2021) and Dergunova et al.(2022), this study reinforces the notion that awareness transforms AI use from a mechanical interaction into a reflective learning process.Students who understand how AI systems function—its biases, limitations, and ethical dimensions—are more capable of questioning, analyzing, and validating the information they receive.This cognitive filtering process nurtures critical engagement rather than passive dependency.

7.2 Comparison with Previous Research

Several prior studies have indicated that AI tools, when used without conscious oversight, may actually hinder critical thinking by fostering automation bias (Zheng et al., 2023; Boustani et al., 2024).However, this study's mediation model clarifies that the problem is not AI itself, but rather the absence of awareness in its use.

Similarly, Alrabiah and Al-Rawi (2023) found that students with higher awareness of AI's cognitive boundaries

demonstrated superior academic performance.The current findings extend these results by providing quantitative evidence ($\beta = 0.582 \to \beta = 0.217 \to \beta = 0.082$, ns) that awareness is not a peripheral factor but a central psychological mechanism linking technological exposure to higher-order learning.

These results also align with Chen and Ramírez (2025), who identified awareness as a "meta-layer of cognition" that mediates the impact of AI-based learning on creative problem-solving and critical analysis. Thus, awareness acts as a **cognitive moderator of authenticity**, ensuring that AI use leads to independent reasoning rather than imitation of machine-generated knowledge.

7.3 Theoretical and Educational Implications

From a theoretical perspective, this study contributes to the emerging cognitive mediation model of AI learning, integrating technology acceptance theory (TAM) with cognitive psychology.The model demonstrates that awareness serves as the missing cognitive bridge that connects technological proficiency with genuine intellectual development.

In practical terms, these findings have profound implications for

universities and policymakers in Lebanon and similar contexts:

1. **Curriculum Design:** Courses should not only introduce AI tools but also integrate **AI ethics, data literacy, and reflective thinking modules**.

2. **Faculty Training:** Professors should be trained to model **critical AI engagement**, encouraging students to evaluate AI-generated outputs critically.

3. **Assessment Practices:** Universities should assess students' **awareness levels** alongside their AI usage to identify patterns of over-dependence or superficial learning.

By incorporating these pedagogical interventions, higher education institutions can transform AI from a convenience tool into a **catalyst for cognitive empowerment**.

7.4 Contextual Reflection: The Lebanese Higher Education System

Within the Lebanese academic landscape, the integration of AI is still in its formative phase. Many universities have adopted digital tools but lack structured programs to cultivate students' AI literacy and ethical awareness.

This study provides timely evidence that awareness-building must precede large-scale AI integration to prevent cognitive passivity and ensure that graduate education fosters genuine intellectual growth.

In this sense, Lebanese universities can lead regional innovation by establishing AI Awareness Centers that train both students and faculty on responsible and creative AI engagement.

8. Conclusions and Recommendations
8.1 Key Findings

This study examined the mediating role of awareness of Artificial Intelligence (AI) technologies in the relationship between AI use and cognitive–scholarly development among postgraduate students in Lebanon.

The results confirmed that while AI use alone does not have a statistically significant direct effect on students' critical thinking and scientific productivity, its indirect effect through awareness is both significant and substantial.

In quantitative terms, the mediation analysis showed:

- **Path a (AI → Awareness):** $\beta = 0.582$, $p < 0.001$
- **Path b (Awareness → Cognitive–Scholarly Development):** $\beta = 0.217$, $p < 0.01$
- **Path c' (Direct Effect):** $\beta = 0.082$, ns
- **Indirect Effect:** $\beta = 0.126$, BootCI [0.070, 0.198]

This confirms that awareness fully mediates the relationship, implying that students who are aware of AI's functions, limits, and biases derive real cognitive benefits, while those who merely "use" it mechanically do not.

8.2 Theoretical Implications

From a theoretical standpoint, this study contributes to the literature by validating the Cognitive Mediation Model of AI Learning, which conceptualizes awareness as a metacognitive filter between technological engagement and intellectual performance. This aligns with emerging theories in digital cognition and AI literacy (Chen & Zhang, 2023; Hornberger et al., 2025), and challenges earlier deterministic assumptions that more technology automatically yields better learning outcomes.

The model proposed here reframes AI not as an independent predictor of learning success, but as a catalyst dependent on awareness — a psychological moderator that determines whether AI use enhances or hinders academic growth.

8.3 Practical and Educational Implications

The study's findings bear several implications for higher education policy and practice, particularly in developing contexts such as Lebanon:

1. **Integrate AI Literacy and Ethics into Graduate Curricula:** Universities should establish mandatory modules on **AI awareness, bias detection, and ethical implications**.These modules must go beyond technical training to include reflective exercises that stimulate students' ability to critique and validate AI-generated content.

2. **Shift from Quantity to Quality of AI Use:** Educational institutions should focus less on how often students use AI tools and more on **how meaningfully and diversely** they use them.Structured assignments that require cross-tool synthesis (e.g., combining ChatGPT, SPSS, and Turnitin outputs) can promote this shift.

3. **Faculty Development Programs:** Lecturers should be trained in **AI-assisted pedagogy** to guide students toward critical and creative usage.This includes workshops on evaluating AI outputs, mitigating bias, and integrating AI into research methodology courses.

4. **Institutional AI Governance Policies:** Universities must develop formal policies defining ethical

boundaries for AI use, covering issues such as **plagiarism detection, data privacy, and disclosure of AI-assisted work**.Transparency reports accompanying theses or projects could enhance academic integrity.

5. **Student Support Centers:** Dedicated AI awareness hubs could provide ongoing mentoring and technical support, bridging the gap between access to technology and cognitive mastery.

8.4 Policy Recommendations for Lebanese Universities

Given Lebanon's transitional digital infrastructure, policymakers in the higher education sector should:

- **Encourage collaboration** between universities and tech companies to design **localized AI training frameworks**.
- **Support research grants** investigating the pedagogical effects of AI awareness on academic performance.
- **Adopt national standards** for AI ethics and educational integration, ensuring equity, inclusivity, and accountability.

By institutionalizing these reforms, Lebanese universities can position themselves as regional leaders in **ethical and critical AI education**.

8.5 Limitations and Future Research

Despite its robust methodology, the study has several limitations:

- It relied on **self-reported data**, which may involve subjective bias.
- The sample was limited to Lebanese universities, which constrains generalizability.
- Other relevant variables, such as **digital self-efficacy, academic motivation**, or **learning styles**, were not included.

Future studies are encouraged to employ **mixed-methods designs** (quantitative and qualitative) and to test the mediation model across multiple cultural and disciplinary contexts.

Moreover, experimental studies assessing the **impact of awareness-training interventions** would provide causal evidence supporting the model proposed here.

8.6 Concluding Remarks

This research underscores a fundamental insight:

Artificial Intelligence does not enhance learning by itself — it enhances those who are aware.

Awareness transforms AI from a mechanical assistant into a partner in thought, enabling students to engage in deeper reasoning, creative synthesis, and scientific innovation.

In Lebanon and similar academic ecosystems, the future of AI in higher education depends not on access to tools, but on the depth of awareness with which those tools are used.

By reorienting educational strategies toward critical, ethical, and diversified AI engagement, universities can cultivate a new generation of researchers capable of shaping—not merely consuming—the future of intelligent education.

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