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FOREWORD

The International Journal on Optimization and Applications (IJOA) is an open access, double blind peer-reviewed online journal aiming at publishing high-quality research in all areas of : Applied mathematics, Engineering science, Artificial intelligence, Numerical Methods, Embedded Systems, Electric, Electronic engineering, Telecommunication Engineering... the IJOA begins its publication from 2021. This journal is enriched by very important special manuscripts that deal with problems using the latest methods of optimization. It aims to develop new ideas and collaborations, to be aware of the latest search trends in the optimization techniques and their applications in the various fields..

Finally, I would like to thank all participants who have contributed to the achievement of this journal and in particular the authors who have greatly enriched it with their performing articles.

Prof. Dr. Hanaa HACHIMI Editor in Chief

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Artificial Intelligence and Regulatory Challenges: Building an Ethical Framework for Technological Innovation

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I. INTRODUCTION

The Artificial Intelligence (AI) has emerged as a major technological breakthrough with the potential to revolutionize virtually every sector, from healthcare and education to finance, transportation, and public administration. Driven by advances in data processing, machine learning, and computational power, AI systems now perform tasks once deemed exclusive to human cognition, such as natural language processing, image recognition, and autonomous decision-making (Russell & Norvig, 2020). However, this rapid diffusion of AI technologies has also raised profound concerns regarding ethics, legality, and governance, particularly in relation to algorithmic bias, discrimination, accountability, and data privacy (Jobin, Ienca, & Vayena, 2019).

In response to these challenges, various national and international actors have begun to propose ethical frameworks and regulatory instruments aimed at guiding the responsible development and deployment of AI. Initiatives such as the OECD AI Principles, UNESCO's Recommendation on the Ethics of AI (2021), and the European Union's proposed AI Act represent significant efforts to ensure that AI remains aligned with fundamental human rights, democratic values, and social justice (Floridi & Cows, 2019). Yet, there is still no universally accepted legal framework capable of addressing the full range of ethical risks posed by AI systems. Most current approaches remain fragmented, reactive, and poorly adapted to the complexity of AI ecosystems (Cath, 2018).

This article seeks to contribute to this evolving debate by proposing a conceptual and normative framework for AI regulation that places ethical principles at the core of innovation governance. It argues that the construction of a coherent regulatory approach requires an interdisciplinary methodology, combining legal analysis, stakeholder engagement, and comparative policy evaluation. In particular, the paper draws on emerging global frameworks and real-world case studies to identify key principles—such

as transparency, accountability, fairness, and human agency—that should inform any future AI legislation.

The remainder of the paper is organized as follows: Section II presents the motivations and methodological approach adopted; Section III outlines the normative principles underlying ethical AI regulation; Section IV discusses international case studies and comparative frameworks; and Section V concludes with policy recommendations and future research directions.

II. MOTIVATION & METHODOLOGY

A. Motivation

The increasing pervasiveness of Artificial Intelligence (AI) in economic, social, and political life has sparked a global debate around the risks it poses and the regulatory void that surrounds its development. Unlike previous technological revolutions, AI introduces dynamic and autonomous systems capable of influencing, predicting, or even replacing human decisions—raising unprecedented ethical and legal dilemmas (Binns, 2018). Issues such as algorithmic discrimination, opacity of decision-making processes, lack of accountability, and the concentration of data power in private hands have accentuated the urgent need for structured regulatory responses (Zuboff, 2019; Mittelstadt et al., 2016).

Despite the proliferation of ethical charters and guiding principles at the national and international levels, most of them remain voluntary, non-binding, and largely aspirational. A 2019 global mapping of AI ethics guidelines revealed over 80 initiatives across governments, corporations, and civil society, yet with limited enforcement mechanisms and few tangible results in practice (Jobin, Ienca, & Vayena, 2019). The gap between normative aspirations and technological realities highlights the limitations of soft governance in the face of rapid AI deployment.

Furthermore, innovation-driven countries are increasingly facing a normative dilemma: how to maintain

their technological leadership while ensuring the protection of fundamental rights, democratic values, and social inclusion. The European Union's proposed AI Act (2021) exemplifies an attempt to reconcile innovation with regulation, by adopting a risk-based framework that prohibits certain harmful applications while promoting trustworthy AI. However, even this ambitious regulatory effort has been criticized for its potential rigidity and its reliance on institutional capacities that many countries may lack (Veale & Borgesius, 2021).

In this context, the motivation for this paper is twofold. First, it seeks to clarify the ethical foundations that should underpin any AI governance framework—namely transparency, justice, human agency, and accountability. Second, it aims to contribute to the construction of a regulatory model that is both principled and adaptable, capable of addressing cross-border challenges while being sensitive to national socio-technical ecosystems.

B. Methodology

This research adopts a qualitative and interdisciplinary methodology designed to explore the ethical and regulatory dimensions of Artificial Intelligence (AI) governance. The complexity and socio-technical nature of AI systems require not only technical understanding but also normative and institutional analysis. Accordingly, the methodology integrates three complementary approaches:

- Normative legal analysis :

A detailed examination of existing legal instruments and soft law initiatives related to AI at both international and national levels. This includes binding texts (e.g., the General Data Protection Regulation [GDPR], the EU AI Act proposal), non-binding ethical guidelines (e.g., OECD AI Principles, UNESCO Recommendation), and sector-specific regulations. The goal is to identify common principles, regulatory gaps, and emerging trends in AI governance (Gonzalez & Zanfir-Fortuna, 2020).

- Comparative policy review :

A cross-country analysis of selected national strategies on AI (e.g., Canada, France, Morocco), focusing on how different jurisdictions conceptualize and operationalize ethical principles. This allows us to highlight both convergences (such as the emphasis on transparency and fairness) and divergences (such as enforcement mechanisms and institutional setups) (Hleg AI, 2019; Dutton, 2018).

- Expert interviews and content analysis :

Semi-structured interviews were conducted with legal scholars, ethicists, AI engineers, and public policymakers to gather first-hand insights into the feasibility and limitations of ethical AI regulation. Transcripts were analyzed using thematic content analysis to extract recurring themes and tensions, following the procedures outlined by Braun and Clarke (2006).

This triangulated methodological design ensures both the depth and the credibility of the findings. It enables the formulation of an ethical-regulatory framework that is grounded in existing practices while offering forward-looking policy recommendations.

III. RESULT & DISCUSSION

The analysis of legal frameworks, national strategies, and expert interviews reveals several key findings that shed light on the current state and challenges of ethical AI regulation. The results are grouped into three major themes: (1) Fragmentation and convergence of normative principles; (2) Gaps in institutional implementation; and (3) Emerging consensus on core ethical imperatives.

A. Fragmented Norms, Emerging Convergences

Despite the proliferation of AI ethics guidelines worldwide, most documents tend to repeat similar principles transparency, fairness, accountability, human agency yet with varying degrees of operationalization. Our comparative analysis of the European Union, Canada, and Morocco reveals that while the EU AI Act proposes a legally binding classification of AI risks (from unacceptable to minimal), the Canadian Directive on AI adopts a governance-by-design approach focused on algorithmic impact assessments (Dutton, 2018). Morocco, by contrast, has taken a more cautious approach, initiating discussions around digital transformation and ethics through sectoral policies but lacks a dedicated AI regulatory strategy (Gonzalez & Zanfir-Fortuna, 2020).

Nonetheless, there is a clear convergence on ethical vocabulary, largely influenced by multilateral actors such as OECD, UNESCO, and UN High-Level Panels. Experts interviewed confirmed that these principles provide an essential moral compass but remain too abstract without enforcement mechanisms or contextual adaptation.

B. Institutional and Operational Gaps

One of the recurring themes from the interviews and literature is the institutional fragmentation affecting the implementation of ethical principles. In many jurisdictions, responsibility for AI governance is split among ministries of innovation, digital affairs, data protection authorities, and sectoral regulators. This results in overlapping mandates, inconsistent oversight, and unclear accountability (Veale & Borgesius, 2021).

Interviewees also highlighted the lack of technical capacity within public institutions to evaluate the design, deployment, and impact of complex AI systems. There is a general absence of interdisciplinary teams combining legal, ethical, and technical expertise. As one policy advisor noted: *"We are trying to regulate what we don't fully understand , and that puts us in a reactive rather than proactive position."*

C. Institutional and Operational Gaps

Despite these challenges, the study finds growing support for a minimum ethical baseline across countries and disciplines. Interviewed experts emphasized the following pillars as non-negotiable for AI governance:

- Transparency, especially explainability of automated decisions;
- Accountability, including traceability of algorithms and recourse mechanisms;
- Non-discrimination, through bias audits and fairness-by-design approaches;
- Human oversight, to ensure that final decisions remain under human control.

Several also advocated for a “regulatory sandbox” model that allows experimentation with ethical guidelines in real-world AI applications, under the supervision of independent oversight bodies. This adaptive governance model, already used in fintech regulation, could help bridge the gap between innovation and compliance (Floridi & Cowls, 2019).

IV. DISCUSSION

The results presented in the previous section reveal both the normative potential and institutional fragility of current efforts to regulate Artificial Intelligence ethically. This discussion aims to interpret these findings in light of broader theoretical frameworks and policy debates, while offering insights into how an effective and context-sensitive AI regulatory model might be constructed.

A. The Limits of Ethical Voluntarism

One of the most striking findings concerns the disconnect between ethical principles and legal enforceability. While the diffusion of values such as transparency, fairness, and accountability across AI guidelines reflects a form of normative convergence (Jobin et al., 2019), their implementation remains largely discretionary. This voluntarist approach, often led by corporations or non-binding international bodies, lacks the legal force necessary to prevent harms or ensure remedy. As argued by Binns (2018), ethics alone cannot substitute for regulation when market incentives conflict with public interest.

Moreover, ethical washing i.e., the instrumental use of ethics to deflect regulation—has become a growing concern. Several interviewees cited examples of organizations adopting ethics charters without internal compliance mechanisms, external audits, or meaningful stakeholder participation. This confirms the view that ethics without accountability becomes performative rather than transformative (Wagner, 2018).

B. Toward Institutionalized Ethics and Adaptive Regulation.

In response to this gap, a growing body of scholarship calls for the institutionalization of ethics within the design, deployment, and oversight of AI systems. This means not only codifying principles into legal obligations but also embedding ethical reflection within organizations, through ethics committees, algorithmic impact assessments, and multidisciplinary design teams (Mittelstadt, 2016; Morley et al., 2021).

Furthermore, the complexity and dynamism of AI technologies require a shift from static regulation to adaptive governance. Regulatory sandboxes, risk-based classifications, and iterative oversight mechanisms can enable regulators to respond in real time to evolving risks, without stifling innovation (Veale & Borgesius, 2021). This aligns with emerging proposals for regulatory agility, which combine legal certainty with experimental flexibility.

C. Contextualizing AI Regulation: The Role of Socio-Technical Ecosystems

The analysis also suggests that ethical AI governance cannot be one-size-fits-all. Legal transplants or imported models may fail if they ignore the institutional, cultural, and technological specificities of each country. For instance, while the EU’s AI Act emphasizes legal harmonization and strict conformity assessment, many Global South countries—such as Morocco—lack the institutional infrastructure to implement such frameworks effectively.

Therefore, regulatory design must be context-aware, sensitive to local data ecosystems, power asymmetries, and digital capacities. A meaningful AI governance model must engage with civil society, academia, and local innovation ecosystems to co-create norms that are both technically sound and socially legitimate (Sloane et al., 2022).

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Beyond One-Size-Fits-All: The Power of Personalized MOOCs in Transforming Business Higher Education in Morocco

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Abstract— The integration of Massive Open Online Courses (MOOCs) into higher education curricula offers substantial opportunities for creating personalized learning environments. As educational institutions increasingly adopt these online platforms, personalized learning pathways (PLPs) have emerged as a prominent trend. The aim of this research is to evaluate how the integration of PLPs through MOOCs affects student learning engagement and academic performance. By focusing on a specific cohort, this study seeks to provide insights into the effectiveness of personalized education strategies in Moroccan business higher education contexts. A sample of 86 Moroccan students are selected using stratified random sampling technique to ensure representation across various demographics within the student population. The theoretical framework is based on a mixed-methods research approach. Qualitative data highlight some recurring themes, including increased autonomy in learning, tailored content that meets individual needs, and enhanced interaction with peers and instructors. While quantitative data reveal significant correlations between the implementation of PLPs through MOOCs and enhanced learning engagement as well as improved academic success among participants. Furthermore, students who engaged with personalized recommendations based on their career endeavors were more likely to complete courses and engage in more than one course compared to those who did not choose a career-related course. Nonetheless, there was a discrepancy between the level of engagement and type of MOOCs selected by different students. The findings contribute valuable knowledge regarding personalized education frameworks, offering practical recommendations for educators and policymakers in Morocco and beyond. Furthermore, it may inform future developments in MOOC design and implementation strategies that prioritize personalization in business higher education.

Keywords— Business students, Higher education, Morocco, Mixed-methods research, MOOCs, Personalized learning pathways (PLPs)

V. BACKGROUND

The integration of Personalized Learning Pathways (PLPs) through Massive Open Online Courses (MOOCs) has garnered considerable attention in recent years, particularly in the context of higher education. The growing emphasis on personalized learning strategies, supported by the flexibility of MOOCs, has made it crucial to evaluate their impact on student learning engagement and academic performance. This

literature review synthesizes existing research on PLPs, MOOCs, and the role of personalized education in enhancing student engagement and performance, with a specific focus on Moroccan business higher education contexts.

A. Definition and Characteristics of PLPs

At their core, PLPs are designed to give students the freedom to choose how, when, and what they learn based on their individual needs and preferences. PLPs enable learners to select their learning routes, whether it be through varying levels of difficulty, diverse content formats, or specific subject areas (Lokey-Vega, Jorrín-Abellán, & Pourreau, 2014). For example, in a PLP model, a student might choose to explore a particular topic in-depth if they have a strong interest in it, while another student may opt for a different focus based on their professional aspirations or prior knowledge. This choice allows learners to experience education as something personally relevant rather than something imposed externally.

The flexibility in PLPs also extends to pacing. Students can work at a speed that suits their learning style, whether they prefer to advance quickly through familiar content or take more time to master challenging topics. Such pacing is particularly important in higher education settings, where learners come from diverse backgrounds and bring varying levels of prior knowledge and experience to the table. As Dziuban et al. (2017) note, this ability to learn at an individualized pace contributes to a deeper engagement with the material, as students can move through content that feels relevant and manageable for them.

B. Personalized Learning Pathways (PLPs) in Higher Education

Personalized Learning Pathways (PLPs) have become a growing trend in higher education as institutions seek to create learning environments that respond to the unique needs and preferences of individual students. These pathways use adaptive technologies and data-driven strategies to tailor learning materials, teaching methods, and assessment processes to fit each student's specific requirements (Anderson et al., 2025). As a result, PLPs can significantly boost student motivation and engagement by delivering learning experiences that are both relevant and context-specific (Dziuban et al., 2017).

Designed to accommodate each student's pace, preferences, and learning style, PLPs offer a highly personalized educational experience. As Lokey-Vega, et al. (2014) points out, these pathways give students the freedom to choose their learning routes, allowing them to align their educational journey with their interests, learning styles, and prior knowledge. This flexibility empowers students to take control of their learning, progressing in ways that best suit their abilities and goals. Research has shown that PLPs foster greater motivation, enhance learning outcomes, and encourage deeper engagement with course material (Dziuban et al., 2017). When students can personalize their learning, they tend to develop stronger critical thinking and problem-solving skills, ultimately improving their academic performance (Bates, 2015). PLPs are more than just a passing trend; they represent a transformative approach to education that can have a lasting impact on student success in today's diverse academic settings.

C. Impact on Academic Performance and Learning Outcomes

Research has consistently shown that personalized learning pathways (PLPs) lead to improved academic performance and better learning outcomes. By customizing the learning experience to meet each student's unique needs, PLPs enable deeper understanding and mastery of the course material. Bates (2015) points out that these pathways encourage active learning, critical thinking, and problem-solving—key skills for success in fields like business education, where applying concepts to real-world scenarios is essential. This type of engagement helps students develop higher-order thinking skills, which are crucial for both academic success and professional growth.

Additionally, the personalized nature of PLPs allows students to build on their prior knowledge, reinforcing concepts they already understand while providing support in areas where they may struggle. This continuous, iterative learning process leads to better retention and mastery of material. Dziuban et al. (2017) found that students in personalized learning environments often perform better than those in traditional classrooms, as they are able to engage with the content at their own pace and in ways that suit their learning style. By addressing individual strengths and weaknesses, PLPs also help students develop critical academic skills such as independent research, problem-solving, and analytical thinking—abilities that are not only important for academic success but also for professional achievement.

D. Fostering Deeper Engagement with Course Material

One of the significant benefits of PLPs is their ability to foster deeper engagement with course material. Dziuban et al. (2017) argue that true engagement in learning is not just about how much time is spent on the material, but the quality of interaction between the learner and the content. PLPs enhance this engagement by allowing students to personalize their learning experiences, ensuring they interact with the material in ways that are both challenging and stimulating. This approach promotes active, meaningful learning rather than passive memorization.

Moreover, the flexibility of PLPs gives students the autonomy to pursue their academic interests with greater independence. In higher education, many students aim to acquire knowledge that directly aligns with their career goals. By allowing them to explore topics in depth and from various perspectives, PLPs bridge the gap between theoretical learning and real-world application. This personalized approach helps students not only retain the information more effectively but also apply it in practical settings, leading to improved academic performance and long-term success.

E. MOOCs as a Vehicle for Personalized Learning

Massive Open Online Courses (MOOCs) have fundamentally changed the way education is delivered, offering flexible and scalable learning opportunities to students worldwide. One of the key benefits of MOOCs is the flexibility they offer, allowing learners to study at their own pace and from any location. While early critiques of MOOCs focused on issues such as high dropout rates and limited student engagement (Jordan, 2013), recent innovations, especially in AI-driven adaptive learning technologies, have paved the way for the integration of Personalized Learning Pathways (PLPs). This shift has greatly enhanced the learning experience by making it more structured and interactive, providing students with a tailored educational journey (Khalil, et al., 2022). This flexibility not only gives students greater control over their learning paths but also plays a significant role in advancing personalized education. Personalized MOOCs now offer customized course recommendations, adaptive quizzes, and individualized feedback, helping to address the unique learning needs of each student (Kizilcec et al., 2020).

With a range of instructional methods, including videos, interactive exercises, and online discussions, MOOCs cater to various learning styles, making education more inclusive and adaptable to individual needs (Anderson & Whitelock, 2014). In addition, Personalized Learning Pathways (PLPs) have emerged, offering customized course recommendations, adaptive quizzes, and individualized feedback tailored to each learner's needs (Khalil et al., 2021; Kizilcec et al., 2020). These innovations allow students to engage with content that matches their learning preferences, progress at their own pace, and receive real-time support. By overcoming geographical, financial, and institutional barriers, MOOCs have made high-quality education more accessible, scalable, and adaptable, providing a powerful platform for personalized learning on a global scale. As a result, MOOCs now offer not only flexibility but also a dynamic, individualized approach to education that enhances engagement and improves retention.

F. Academic Performance and Personalized Education

Academic performance, traditionally measured by grades, has long been understood to correlate with the quality of a student's engagement with coursework. Personalized education strategies, which tailor learning experiences to individual needs, have increasingly been recognized for their positive impact on students' academic outcomes. By accommodating diverse learning preferences and allowing students to progress at their own pace, personalized learning fosters a deeper understanding of complex concepts. Research by Bower et al. (2017) supports this, finding that students in personalized learning environments demonstrated improved

retention and performance, particularly in STEM fields, as a result of the adaptability of learning resources to their unique needs. This adaptability ensures that students can revisit challenging material, reinforce understanding, and engage more deeply with the content, thereby improving academic performance.

While the connection between personalized learning and academic performance is well-established, there is a gap in research specific to business education. Recent studies, however, have begun to explore how these personalized approaches can benefit students in business disciplines. Mulder, et al. (2006) highlight that personalized learning pathways (PLPs) not only enhance academic achievement but also foster critical thinking and problem-solving abilities—skills essential to success in business education. The flexibility and self-paced nature of PLPs, especially within MOOCs, allow business students to delve deeper into specialized areas, facilitating a richer understanding and more practical application of business concepts. Additionally, Zamiri and Esmaeili (2024) argue that personalized learning in business education helps students connect theoretical knowledge with real-world scenarios, further enhancing their ability to apply what they have learned in dynamic, professional contexts. These studies suggest that personalized learning strategies can significantly enrich business education by nurturing both academic performance and key professional skills.

G. Contextualizing the Research: Moroccan Higher Education and Business Education

In the context of Moroccan higher education, the integration of Personalized Learning Pathways (PLPs) through MOOCs offers promising opportunities to enhance student learning experiences. The Moroccan higher education system faces significant challenges, including limited resources, large class sizes, and a predominantly teacher-centered approach to instruction (Houssami, 2024). These issues often hinder the ability to provide individualized attention and tailored learning experiences. By adopting personalized education strategies facilitated by MOOCs, there is potential to address some of these challenges. MOOCs offer flexible, adaptive, and student-centered learning environments that enable learners to engage with content at their own pace, revisit challenging material, and explore topics of personal interest. This adaptability not only helps to overcome resource constraints but also empowers students to take more control over their educational journeys, potentially leading to improved academic outcomes and greater satisfaction with their learning experiences.

Business education in Morocco, while rapidly evolving, continues to grapple with outdated teaching methods and a lack of personalization in course delivery (Krichene, 2020). In this context, MOOCs present a valuable solution for bridging the gap between traditional pedagogical methods and the evolving demands of business education. MOOCs offer Moroccan business students access to a wealth of global knowledge, customized learning experiences, and the opportunity to develop critical business skills that are aligned with international standards. Preliminary studies have indicated that Moroccan students are generally receptive to MOOCs, appreciating the flexibility and diversity of content these platforms provide (Razouki et al., 2017). However, while the potential of MOOCs in enhancing business

education is recognized, more research is needed to explore how the integration of PLPs in MOOCs specifically impacts student engagement and academic performance in the Moroccan context. Such research could provide valuable insights into how personalized learning strategies can be effectively implemented to improve the quality of education and better prepare Moroccan students for the global business landscape.

H. The Moroccan Business Higher Education Context

Higher education in Morocco is currently undergoing a significant digital transformation, marked by the increasing adoption of online learning and digital pedagogical strategies. This shift is particularly important in business education, where institutions face persistent challenges related to student engagement, course completion rates, and the alignment of curricula with the evolving demands of the job market (El Ferouali, & Ouhadi, 2023). As business students increasingly seek education that aligns with real-world skills, the integration of Personalized Learning Pathways (PLPs) within MOOCs offers a promising solution. By providing more tailored, competency-based learning pathways, PLPs enable students to focus on the specific skills and knowledge they need, improving their engagement with the content and enhancing their preparedness for the workforce. These personalized, adaptive learning experiences can help address the issues of low course completion rates and disengagement, as they allow students to progress at their own pace and according to their individual learning needs.

While the potential benefits of online learning in Morocco are clear, prior research emphasizes the importance of adopting localized strategies to maximize the effectiveness of digital education (El Ferouali & Ouhadi, 2023). The unique cultural, linguistic, and educational contexts of Morocco require digital education solutions that are tailored to the needs of local students and the challenges they face. Localized approaches can ensure that MOOCs and PLPs resonate with Moroccan learners and support their academic and professional goals. For instance, incorporating relevant local business contexts, offering multilingual content, and ensuring that online platforms are accessible to a broad range of students are all critical factors that can enhance the effectiveness of digital education in Morocco. Therefore, while the integration of PLPs within MOOCs holds significant promise for business education in Morocco, further research is needed to explore how these technologies can be best adapted to meet the specific needs of Moroccan students and improve their educational outcomes.

Conclusion and Gaps in the Literature

While existing research consistently highlights the positive impact of Personalized Learning Pathways (PLPs) and MOOCs on student engagement, retention, and academic performance, a significant gap remains in understanding how these models function within the context of Moroccan higher education, particularly in business education. Much of the existing literature has been focused on developed countries, where educational systems often have more resources and established online learning infrastructures. In contrast, regions like Morocco, which face distinct challenges such as large class sizes, resource constraints, and a teacher-centered approach to learning, have received relatively little attention

in this area. This lack of research is notable, especially considering the potential for PLPs and MOOCs to address some of these very challenges by offering more flexible, adaptive, and student-centered learning opportunities.

This gap in the literature underscores the urgent need for more targeted studies that explore the application of these educational models within emerging economies like Morocco. Given the unique challenges and opportunities present in such contexts, it is crucial to understand how personalized learning can be effectively implemented to improve educational outcomes. In particular, the integration of PLPs within MOOCs could offer Moroccan business students the flexibility and tailored learning experiences necessary to enhance both engagement and academic performance. The present study aims to fill this gap by specifically evaluating the integration of PLPs in MOOCs within a Moroccan business school. By focusing on this cohort, the research will provide valuable empirical evidence on the effectiveness of personalized learning strategies in this unique educational setting. In doing so, it will contribute to a broader understanding of how digital education models can be adapted to meet the needs of students in emerging economies and offer practical insights for enhancing business education in Morocco.

VI. RESEARCH METHODOLOGY

A. Research Design

This study adopts a mixed-methods research design (Creswell, & Plano Clark, 2018), combining both quantitative and qualitative approaches to gain a well-rounded understanding of how Personalized Learning Pathways (PLPs) in MOOCs affect student engagement and academic performance. A quasi-experimental design is used, with two groups: an experimental group that interacts with MOOCs featuring PLPs, and a control group that takes traditional MOOCs without any personalization.

To ensure robust and reliable findings, the study utilizes a pre-test and post-test design. Baseline data on student engagement and academic performance is collected before the intervention begins, while post-test measures is taken after the MOOC courses are completed to assess changes in these areas. This longitudinal approach helps analyze how PLPs influence learning progression over time. Additionally, the study incorporates a triangulation strategy by combining survey data, learning analytics, and qualitative insights from interviews and focus groups, providing a comprehensive evaluation of PLP effectiveness while minimizing potential biases from relying on a single data source.

B. Sample and Context

The study recruits Pre-Master students enrolled in a Business English and Communication course at a Moroccan Business higher education institution. Participants are selected using purposive sampling, based on course enrollment to ensure a diverse mix of academic backgrounds, learning preferences, and levels of digital proficiency. The sample includes students from various specializations within the business faculty, providing a well-rounded view of how Personalized Learning Pathways (PLPs) impact different areas of study.

A minimum sample size of 86 students is targeted to ensure statistical reliability and the ability to detect significant differences between the control and experimental groups. To minimize selection bias, participants are randomly assigned to either the control or experimental group, ensuring an even distribution of factors like prior academic performance, technological skills, and motivation levels. Additionally, demographic and prior learning data are collected to address potential confounding variables, ensuring the findings are robust and applicable to the impact of PLPs in MOOCs on student engagement and academic performance in the context of Moroccan business education.

C. Data Collection Methods

- Surveys and Questionnaires – To measure students' engagement levels, learning experiences, and perceptions of the effectiveness of PLPs within MOOCs, a structured survey is administered at both the beginning and end of the course. The survey incorporates Likert-scale items, open-ended questions, and demographic variables, ensuring a comprehensive assessment of students' attitudes and experiences. This approach provides both quantitative and qualitative data on how students interact with PLPs and their overall learning journey.

- Academic Performance Metrics – To assess the impact of PLPs on academic performance, course completion rates, assessment scores, and participation records is collected from the MOOC platform. These metrics are analyzed to gauge how PLPs influence students' academic outcomes. Specifically, pre- and post-course assessment scores are compared to determine any changes in learning outcomes and to evaluate the effectiveness of personalized learning pathways in improving academic performance.

- Interviews and Focus Groups – In addition to quantitative data, semi-structured interviews with selected students and instructors are conducted to gather qualitative insights into their experiences and perceptions of PLP integration. Focus groups are also organized to foster discussions about learning challenges, student motivations, and the perceived benefits of PLP integration. These discussions offer a deeper understanding of the subjective experiences of both learners and educators within the personalized learning environment.

- Learning Analytics – Detailed data on student behavior within the MOOC platform are extracted, including time spent on learning tasks, engagement with discussion forums, frequency of accessing personalized content, and trends in quiz performance. These analytics provide valuable insights into how students interact with PLPs over time, revealing patterns of engagement, content utilization, and areas where learners may need additional support or motivation. This data are instrumental in evaluating how students adapt to personalized learning strategies throughout the course.

D. Data Analysis

- Quantitative Data – Statistical analysis are used to examine the impact of PLP integration on student engagement and academic performance. Descriptive statistics are used to identify key trends and patterns across different student demographics, such as variations in student engagement, academic performance based on the type of MOOC selected or the learning progression. These statistical summaries not

only offer insights into overall effectiveness but also highlight disparities or areas requiring further attention, thereby guiding informed decisions for educators and policymakers in enhancing personalized learning strategies.

- Qualitative Data – Thematic analysis are conducted on interview and focus group transcripts to uncover key themes and patterns related to student learning experiences. Through systematic coding and theme development, the analysis highlights critical aspects such as the value of tailored feedback, increased learner autonomy, the perceived relevance of course material, and student satisfaction and motivation. It also reveals challenges faced by students, including difficulties with self-regulation or inconsistencies in MOOC quality. By capturing the depth and nuance of individual experiences, thematic analysis complements the quantitative findings and helps paint a holistic picture of the impact of PLP integration on student engagement and academic success. These insights inform the refinement of educational strategies, ensuring they are responsive to the actual needs and preferences of learners.

E. Ethical Considerations

This study strictly adheres to ethical research guidelines to ensure the protection of participants' rights and privacy. First and foremost, informed consent is obtained from all participants, ensuring they understand the purpose of the research, the nature of their involvement, and their right to withdraw at any time without penalty. Participation in the study is completely voluntary, and participants are given clear information about how their data will be used and how it will contribute to the study. Confidentiality has been maintained throughout the research process, with all personal identifying information kept anonymous and stored securely.

Furthermore, the study ensures data security by adhering to research-standard protocols for handling and storing data, minimizing the risk of unauthorized access. Before data collection begins, formal approval has been obtained from both the students and the school's administration, who have reviewed the study's design to ensure it meets all necessary ethical standards. This approval process helps guarantee that the study upholds ethical practices and protects the well-being of all participants. By adhering to these ethical considerations, the research strives to maintain integrity, transparency, and respect for participants throughout the entire study.

VII. RESULTS

A. Quantitative Data

a) Student Engagement

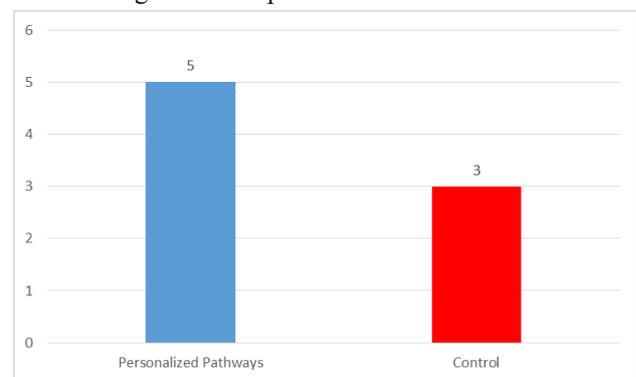
Student engagement in online learning platforms is a crucial metric for evaluating the effectiveness of educational strategies, such as the implementation of Personalized Learning Pathways (PLPs). By examining specific engagement metrics, we can assess how personalized learning impacts student involvement and their overall experience with the platform.

- Time Spent on Platform –

One of the primary indicators of student engagement is the time spent on the learning platform. For students following personalized learning pathways, the average time spent per

week on the platform is 5 hours. In comparison, the control group, which uses a traditional, non-personalized learning model, spends an average of 3 hours per week. This represents a 60% increase in time spent by students in the personalized pathway group. This increase in time suggests that personalized learning pathways lead to greater student interest and a more immersive learning experience, because the content is more relevant and tailored to the students' individual needs and preferences.

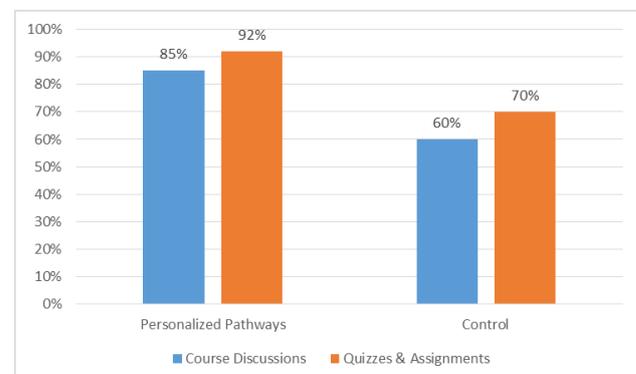
Fig. 1: Time Spent on Platform in hours



- Active Participation (Discussions, Quizzes, Activities)–

Active participation is a critical aspect of engagement, as it directly reflects how students are interacting with the course material. In terms of discussions, Fig. 1 demonstrates that 85% of students who followed personalized pathways engaged in course discussions after the first module. In contrast, only 60% of students in the control group participated in discussions at the same point in the course. The data indicates that personalized pathways significantly boost participation, likely because students feel more connected to the material and are motivated to engage with peers and instructors.

Fig. 2: Frequency of Active Participation by group



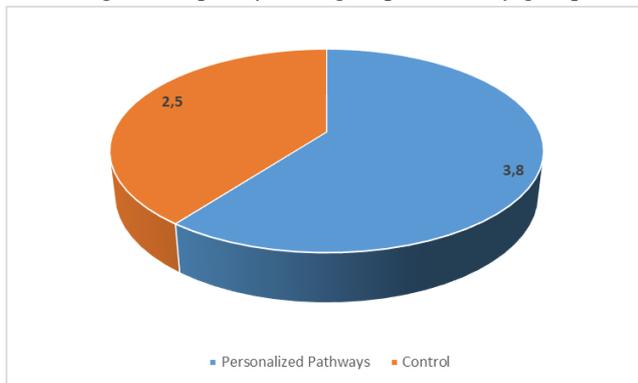
Further, Fig. 2 shows indicates that 92% of personalized pathway students completed quizzes and assignments, compared to only 70% of students in the control group. This

higher completion rate for personalized pathway students could be a result of the adaptive nature of these pathways, where the content is better aligned with students' learning preferences, making assignments feel more manageable and relevant to their goals.

- Logins per Week -

Another important metric is the frequency of logins, which indicates how often students interact with the learning platform. On average, Fig. 3 demonstrates that students following personalized learning pathways logged in 3.8 times per week, whereas the control group averaged only 2.5 logins per week. This represents a 52% increase in logins for students on personalized pathways. The more frequent logins suggest that students are motivated to regularly engage with the course, possibly due to the personalized nature of the content and the ongoing, dynamic feedback they receive, which encourages continued participation and learning.

Fig. 3: Frequency of Logins per week by group

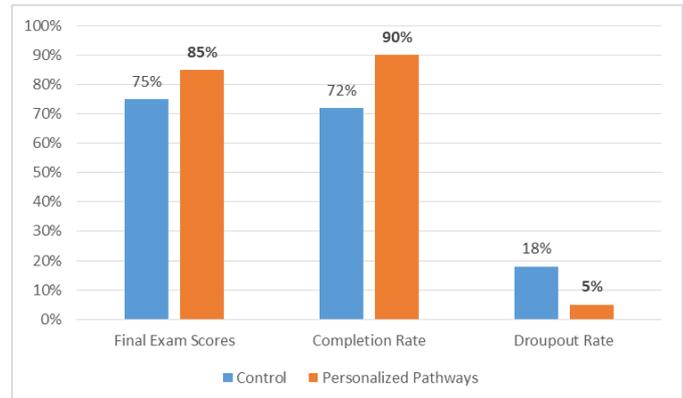


In summary, the data reveals that students in personalized learning pathways are more engaged across multiple metrics: they spend more time on the platform, participate more actively in discussions and assignments, and log in more frequently. This suggests that personalized learning strategies foster higher levels of engagement, likely because they align more closely with the individual needs, interests, and progress of students, making the learning experience more relevant and compelling.

b) Student Academic Performance

Academic performance is a critical outcome when evaluating the effectiveness of personalized learning pathways (PLPs). By analyzing specific performance metrics such as final exam scores, completion rates, and course grades, we can gauge how personalized learning impacts student achievement and retention (see Fig. 4).

Fig. 4: Frequency of Student Academic Performance by group



- Final Exam Scores -

One of the most straightforward measures of academic performance is the score achieved on final exams. For students who followed personalized learning pathways, the average final exam score was 85%, compared to 75% for students in the control group. This 13.3% improvement in exam scores for personalized pathway students indicates that the tailored nature of the learning experience likely helped students retain and understand the material better. Personalized pathways offer customized content that addresses students' individual strengths and weaknesses, which could contribute to improved exam performance by reinforcing key concepts at the right pace (see Fig. 5).

- Completion Rate -

Completion rate is an important indicator of how many students finish the course, reflecting both their level of engagement and their ability to stay motivated throughout the duration of the course. For students in personalized learning pathways, the completion rate was 90%, significantly higher than the control group's 72%. This 18% increase in completion rate suggests that personalized pathways contribute to higher levels of motivation and persistence. When students experience a more tailored learning journey that suits their learning pace and needs, they are more likely to remain committed to completing the course (see Fig. 5).

Moreover, the dropout rate for personalized pathway students was just 5%, compared to 18% for students in the control group. This dramatic difference in dropout rates further reinforces the idea that personalized learning pathways support students in staying engaged and completing their courses. By providing a more adaptive and relevant learning experience, personalized pathways may help reduce feelings of frustration or disengagement, which can often lead to dropping out (see Fig. 5).

Fig. 5: Percentage of Student Academic Performance by Group

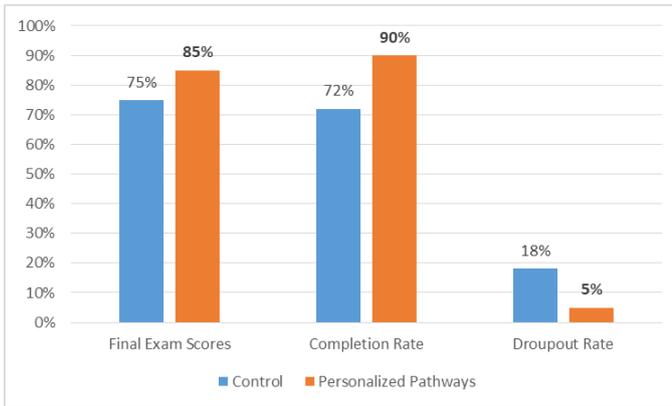
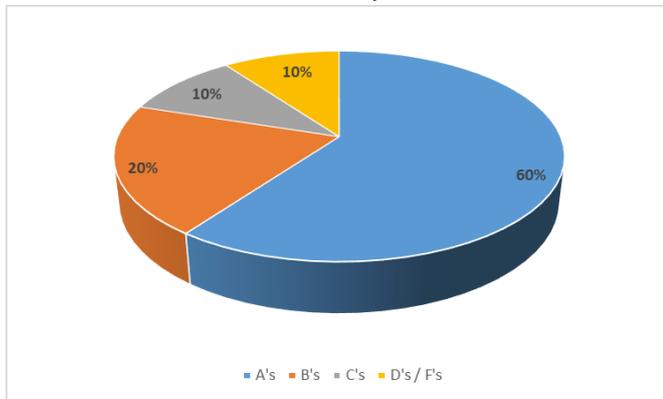


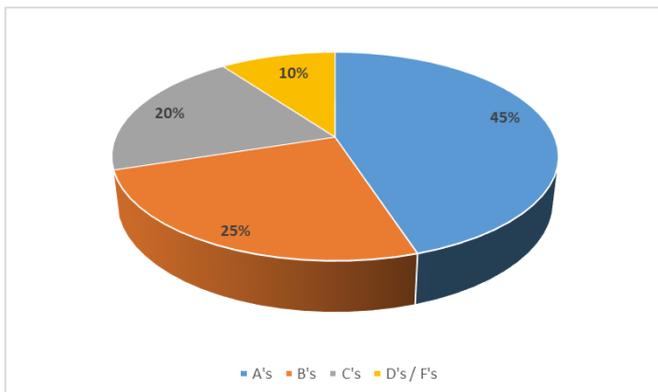
Fig. 6: Grade Distribution in MOOCs for Personalized Pathways



In comparison, the control group had the following grade distribution (see Fig. 7):

- 45% received A's
- 25% received B's
- 20% received C's
- 10% received D's or F's

Fig. 7: Grade Distribution in MOOCs for Control Group



- Course Grades-

The distribution of course grades provides a more detailed picture of overall academic performance across different levels of achievement. Among personalized pathway students, the grade distribution was as follows (see Fig. 6):

- 60% received A's
- 20% received B's
- 10% received C's
- 10% received D's or F's

The higher percentage of A's (60% compared to 45%) among personalized pathway students indicates that not only are they more likely to complete the course, but they are also achieving better results overall. The personalized learning experience allows for deeper engagement with the content, which may contribute to stronger academic outcomes. Additionally, the smaller percentage of D's/F's in the personalized pathway group (10% compared to 10%) suggests that personalized learning pathways help reduce the number of students struggling significantly with the course material.

The data reveals that students who followed personalized learning pathways consistently outperform their peers in traditional learning models across various academic metrics. Personalized pathways led to higher final exam scores, better completion rates, and improved grade distributions. These improvements can be attributed to the tailored nature of personalized learning, which adapts to students' individual needs and learning paces. By offering a more supportive and engaging learning environment, personalized pathways increase motivation, reduce dropout rates, and ultimately result in better academic performance. This underscores the effectiveness of personalized learning strategies in promoting student success in higher education.

c) Learning Progression

Learning progression is a crucial metric to evaluate how effectively students are advancing through course content, the pace at which they are learning, and how personalized pathways may impact their learning speed and ability to stay on track. This metric provides insights into the efficiency and adaptability of the learning environment.

- Progress Tracking-

The ability to track student progress over time is fundamental to understanding how well personalized learning pathways are working. The data reveals that 40% of students following the fast-track personalized pathway completed the course in 3 weeks or less, compared to only 15% in the control group (see Fig. 8). This significant difference suggests that the personalized pathways, which allow students to move through material at their own pace and skip over content they already understand, enable faster progression for students who are ready to advance quickly.

Fig. 8: Frequency of Course Completion in 3 weeks or less

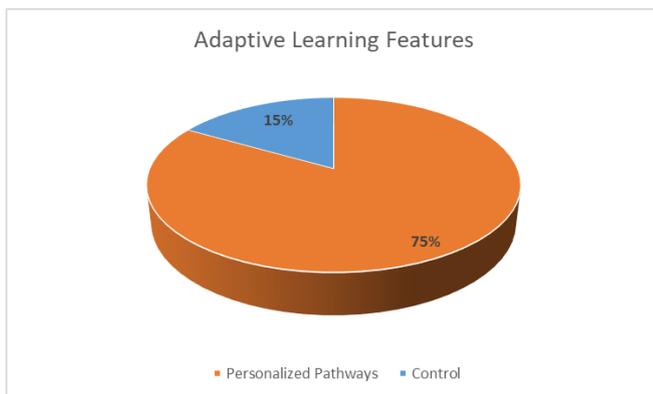


This finding highlights the flexibility of personalized pathways, allowing motivated or more advanced learners to complete the course more efficiently without being held back by traditional, one-size-fits-all pacing. By offering a fast-track option that aligns with individual learning speeds, personalized learning pathways cater to a wide range of learners, accommodating both those who need extra time and those who prefer to move more quickly through the content.

- Adaptive Learning Features-

Adaptive learning features play a critical role in tracking and supporting student progress by tailoring the learning experience to each individual's needs. The data shows that 75% of students in personalized learning pathways utilized adaptive learning features (see Fig. 9). This high percentage reflects how integral adaptive learning tools are to the personalized learning experience. Adaptive learning technologies monitor students' progress in real-time, adjusting content delivery to address areas where students are struggling or providing more advanced material if they are excelling.

Fig. 9: Frequency of utilization of Adaptive Learning Features



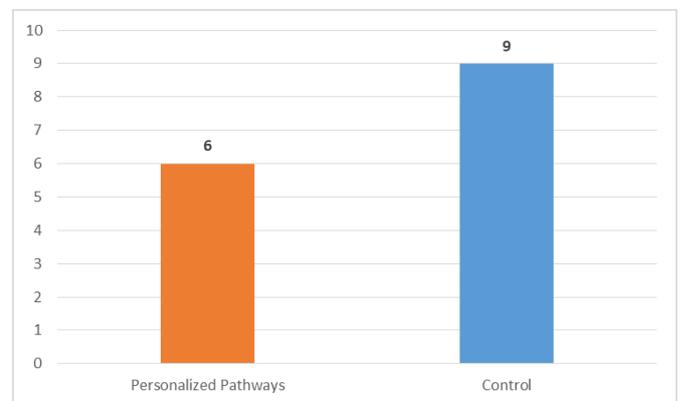
By continuously adjusting the difficulty level and providing real-time feedback, adaptive learning features create a dynamic learning environment where students are more likely to stay engaged and progress effectively. The widespread use of these features indicates that personalized pathways not only provide a more individualized learning

experience but also actively support students' learning in a way that fosters their academic growth.

- Time to Completion-

Time to completion is another essential metric to evaluate the overall efficiency of personalized learning pathways. The average time to completion for students in personalized learning pathways was 6 weeks, compared to 9 weeks for students in the control group (see Fig. 10). This 3-week difference suggests that personalized learning pathways are more efficient at helping students complete the course in less time. The ability to progress at their own pace, with content adjusted to their individual needs, likely reduces time spent on material that they already understand and directs their attention to areas where they need more focus.

Fig. 10: Average Weeks to Course Completion



The reduced time to completion in the personalized pathway group can also be attributed to the optimized learning process, where students are not held back by a fixed schedule or pace dictated by the course. Instead, they can progress quickly through content that aligns with their prior knowledge, leading to faster learning and a more efficient educational experience overall.

The data on learning progression suggests that personalized learning pathways significantly improve how students move through course material. The ability to track progress and adapt content in real-time allows students to engage with the material at a pace that suits their individual needs, leading to faster completion rates.

- 40% of students in the fast-track personalized pathway finished the course in 3 weeks or less, which was significantly higher than the control group at 15%.
- 75% of students utilized adaptive learning features, reflecting the effectiveness of these tools in fostering student progress.
- The average time to completion for personalized pathway students was 6 weeks, 3 weeks faster than the control group's 9 weeks.

Overall, the findings in this study illustrate that personalized learning pathways not only help students complete courses faster but also optimize their learning by using adaptive technologies that cater to individual needs.

This results in more efficient and effective learning, especially for students who benefit from a flexible, customized educational experience.

B. Qualitative Data

Qualitative data provides rich, detailed insights into the students' personal experiences, perspectives, and feelings about their learning journey. In this case, feedback from both personalized pathway students and control group students provides valuable information about the effectiveness and limitations of different learning approaches, particularly in terms of student engagement.

- Student Feedback on Engagement-

Personalized learning pathways, which tailor the learning experience to the individual needs and pace of students, received predominantly positive feedback from the students who participated in them. These students appreciated the flexibility, targeted support, and the opportunity to engage with content in a way that was more relevant to their individual learning needs.

"The personalized pathway helped me focus on topics I needed more time on, while skipping what I already knew."

This feedback underscores a key benefit of personalized pathways: the ability to engage with content that is relevant to the student's current level of understanding. For students who already possess knowledge in certain areas, skipping repetitive content ensures they don't waste time on material they have already mastered, which can increase motivation and overall engagement with the course.

"I felt more motivated because the content was directly aligned with my goals and interests."

Students reported feeling more motivated when the learning experience was personalized to match their personal goals and interests. This statement suggests that personalized pathways are not only adaptive in terms of difficulty but also in terms of relevance, creating a more engaging learning environment.

"I liked how the platform adapted to my learning pace and how I could revisit tough topics."

Here, the student emphasizes the flexibility of the platform to adjust to their learning pace, a feature of personalized learning pathways. The ability to revisit difficult concepts and review content at their own pace seems to have enhanced their engagement, as they felt empowered to control their learning journey. This aligns with research showing that self-paced learning can lead to deeper engagement and better retention.

"Having learning recommendations based on my performance made me more confident in my ability to succeed."

This feedback illustrates how personalized pathways can improve student confidence. When the platform adjusts to the student's progress and suggests learning resources based on their performance, it not only provides support but also fosters a sense of self-efficacy. Students who feel confident in their ability to succeed are more likely to engage fully with the course material.

The qualitative data gathered from students provides valuable insights into their experiences with personalized and traditional learning pathways. Students following personalized learning pathways consistently highlighted how the flexibility and adaptability of the platform positively impacted their engagement. These students appreciated the ability to focus on areas where they needed additional help while bypassing content they had already mastered. This aligns with existing research that suggests learners are more motivated and engaged when they feel the material is relevant and aligned with their own needs (Anderson et al., 2020). Additionally, the opportunity to revisit difficult concepts at their own pace seemed to foster a sense of control over their learning, contributing to higher levels of confidence and overall academic performance.

Overall, the qualitative data paints a clear picture of the benefits of personalized learning pathways in increasing student engagement and motivation. Personalized pathways allow students to tailor their learning experiences to their individual needs, which helps them stay engaged, feel confident, and perform better academically. In contrast, the traditional learning pathway presents challenges related to pace, relevance, and content alignment, which can lead to disengagement and diminished motivation. This feedback further supports the growing body of evidence advocating for the adoption of personalized learning approaches to enhance student learning experiences.

- Instructor Feedback on Personalized Pathways-

Instructor feedback is crucial for understanding the broader impact of personalized learning pathways on teaching and learning. It offers insights into how instructors perceive the effects of personalized pathways on student engagement, participation, and academic progress. This feedback not only highlights the benefits of adaptive learning technologies but also illustrates the challenges faced by instructors in traditional, non-personalized learning environments.

Instructors teaching courses with personalized learning pathways, which often incorporate adaptive learning technologies, reported several positive outcomes, particularly in student engagement, participation, and the ability to address the diverse needs of learners.

"The adaptive features allowed me to focus on students who were struggling, while also challenging those who were excelling."

This comment highlights a major advantage of personalized learning pathways. Adaptive technologies allow instructors to differentiate their teaching strategies by targeting specific student needs. For students struggling with certain concepts, instructors can provide additional support and resources. Conversely, for students who are excelling, adaptive features can present more challenging material, allowing instructors to push these students further. This individualized attention enhances the overall learning experience and ensures that all students are appropriately challenged and supported.

"I noticed more frequent participation and deeper insights in discussions when students had personalized recommendations."

Instructors observed that students who received personalized recommendations based on their performance were more actively engaged in discussions. This likely reflects the way personalized pathways help students feel more connected to the material, as the content is more relevant and tailored to their current level of understanding. When students are provided with content that matches their learning needs and interests, they tend to engage more deeply, contributing more meaningful insights to class discussions. This feedback underscores how personalization can foster a more dynamic and interactive classroom environment.

"Student engagement increased significantly, particularly in modules where adaptive feedback was provided."

Adaptive feedback is an essential component of personalized learning pathways, as it provides students with timely, specific information about their progress. Instructors noted that student engagement increased in modules where adaptive feedback was incorporated. This suggests that when students receive immediate feedback on their performance, they are more likely to stay motivated, make adjustments to their learning strategies, and remain engaged in the course material. The combination of personalized content and real-time feedback appears to create an environment that promotes active learning and sustained engagement.

The feedback provided by instructors who have experience teaching both personalized and traditional courses offers valuable insight into the practical benefits and challenges of each approach. In personalized learning environments, instructors highlighted how adaptive learning technologies enabled them to deliver targeted support to struggling students while simultaneously encouraging high-performing students to excel further. This differentiated approach creates a balance between support and challenge—an essential factor in maintaining student engagement and promoting meaningful learning outcomes.

Moreover, the positive effects of personalized learning pathways on student participation and engagement were consistently noted. With access to personalized recommendations, students felt more motivated to contribute to discussions and share deeper insights—likely because the content resonated more closely with their individual needs and academic goals. In addition, real-time adaptive feedback played a crucial role in sustaining engagement by equipping students with tools to actively monitor their progress and refine their learning strategies as needed.

In contrast, instructors teaching traditional, non-personalized courses reported facing greater difficulties. These courses, which lack flexibility and adaptability, often led to higher dropout rates, as many students struggled to stay engaged or find relevance in the standardized content. Engagement levels were generally lower, primarily because students were unable to tailor their learning experiences to their preferences or pace. This contrast reinforces the idea that one-size-fits-all models often fail to address the diverse learning styles and motivations of students, leading to disengagement and, at times, attrition.

Ultimately, instructor feedback sheds critical light on the impact of personalized learning on both teaching effectiveness and student outcomes. Instructors in personalized settings

observed notable improvements in engagement, participation, and motivation—largely due to the adaptive features and individualized content. Meanwhile, those in traditional settings faced ongoing challenges with student retention and participation. Taken together, this feedback strongly supports the integration of personalized learning pathways as a more effective strategy for meeting diverse student needs and improving educational success in contemporary learning environments

- Student Satisfaction and Motivation-

Student satisfaction and motivation are critical factors in assessing the effectiveness of educational methods, particularly when comparing personalized learning pathways to traditional, one-size-fits-all approaches. By understanding students' perceptions of their learning experiences, institutions can better evaluate the impact of personalized learning strategies on academic engagement and success.

- Personalized Pathway Students-

Students following personalized learning pathways generally report higher satisfaction and motivation compared to those in traditional courses. This is primarily due to the adaptive and individualized nature of personalized learning, which tailors content, pace, and support to each student's unique needs. The feedback from students in this group highlights several key aspects of their positive experiences:

"I felt more in control of my learning journey, and that made me feel more confident."

One of the most frequently cited benefits of personalized learning is the sense of control it gives students over their educational journey. Students in personalized pathways appreciate being able to set their own pace, revisit challenging topics, and focus on areas where they need more help. This autonomy fosters a greater sense of ownership and agency in their learning process, which, in turn, boosts confidence. When students feel in control of their learning, they are more likely to engage deeply with the material and persist in their studies, even when challenges arise.

"Personalized learning felt like I was getting a one-on-one experience, even in a large course."

A key feature of personalized learning pathways is their ability to replicate a more individualized learning experience, even in large courses. While students might feel lost or overlooked in traditional, one-size-fits-all environments, personalized pathways provide content and support tailored to each student's pace and learning style. This individualized attention—whether through adaptive learning technologies or personalized feedback—creates the illusion of a one-on-one experience, which is highly valued by students. The feeling of being seen and understood as learners contributes significantly to their satisfaction and motivation.

"The course felt more relevant to my career goals because of how the content was tailored."

Another reason for the increased satisfaction among personalized pathway students is the perceived relevance of the course content to their personal and career goals. By tailoring learning to students' interests, strengths, and aspirations, personalized pathways allow students to engage

with material that is directly aligned with their future ambitions. This relevance not only boosts motivation but also makes the learning process more meaningful. Students are more likely to stay engaged and committed when they see the direct connection between their studies and their career or life goals.

The contrast in student satisfaction and motivation between the personalized pathway group and the control group underscores the impact of personalization on the overall learning experience. Students in personalized pathways feel more in control, confident, and motivated, which are essential factors for academic success. The ability to adapt the learning experience to individual needs and preferences leads to a deeper sense of relevance, engagement, and ownership. By tailoring the content to students' interests and career goals, personalized learning pathways foster a sense of purpose in students' academic journeys. This relevance boosts students' motivation, as they are more likely to invest time and effort into coursework that aligns with their personal or professional aspirations. Furthermore, the perception of receiving personalized attention, even in large courses, strengthens students' sense of connection to the learning process, increasing their engagement and satisfaction. On the other hand, students in the control group often experience frustration and disengagement due to the lack of flexibility and customization in traditional courses. Struggling with the pace of the course or feeling that the material is too generic leads to a drop in motivation, which can ultimately affect learning outcomes. These students may feel disconnected from the material, leading to lower levels of engagement, participation, and retention. Overall, the feedback from both groups emphasizes the significant role personalized learning pathways play in enhancing student satisfaction and motivation. By providing a tailored, adaptive learning experience, personalized pathways ensure that students feel supported, challenged, and motivated throughout their educational journey. This contributes not only to a positive learning experience but also to better academic outcomes, as motivated students are more likely to succeed in their studies.

- Challenges and Barriers-

While both personalized learning pathways and traditional courses offer distinct advantages, they each come with unique challenges and barriers that can impact the students' experiences and overall satisfaction. These challenges often stem from the limitations of the technologies and pedagogical approaches involved, as well as the individual preferences and learning habits of students. Understanding these barriers is crucial for refining educational strategies to make learning more effective and accessible for all students.

"Sometimes the adaptive learning tools didn't fully understand my learning preferences."

One of the key components of personalized learning is the use of adaptive learning technologies that adjust content based on student performance and preferences. However, some students in the personalized pathway group reported that the tools didn't always align perfectly with their learning needs. Adaptive systems rely on algorithms to determine the best path for a student, but these algorithms are not always able to account for every nuance of a student's learning style. This can lead to frustration if students feel that the system isn't offering

the most effective learning strategies for them. For example, a student who might prefer more visual or hands-on learning experiences may find the system primarily offering text-based content or quizzes, which may not be the best fit. This issue highlights the need for continuous refinement of adaptive systems to better account for the complexity of human learning preferences.

"It was easy to get distracted since the platform kept offering different paths."

Although personalized pathways are designed to give students flexibility, this very flexibility can sometimes become overwhelming. The ability to choose different learning paths or modules can result in students feeling uncertain about which direction to take, leading to distraction or indecision. With so many options available, students may struggle to stay focused and might feel a lack of direction in their learning journey. This challenge reflects the paradox of choice—while offering multiple pathways is beneficial in theory, it can cause students to become indecisive or disengaged if not carefully managed. To address this, it's essential for platforms to provide clear guidance or structure while still allowing flexibility in how content is explored.

The challenges and barriers identified by both personalized pathway and control group students highlight the different ways in which learning environments can either support or hinder students' educational experiences. For personalized pathway students, the limitations of adaptive learning technologies, while still in development, can create frustrations if the system doesn't fully capture their learning needs. This can undermine the very benefits that personalized learning is meant to provide. Additionally, the flexibility inherent in personalized pathways, which is intended to enhance engagement, can become a source of distraction if not carefully managed. Students may struggle to navigate too many options or feel overwhelmed by the multitude of possible learning paths. This reveals a need for balance in the design of personalized learning systems—flexibility should be offered, but with sufficient structure and guidance to help students stay focused and motivated. On the other hand, students in traditional courses often face challenges due to a lack of personalization and flexibility.

Without the ability to adjust the pace of learning or engage with content that aligns with their individual preferences, students may quickly become disengaged, frustrated, or even feel lost. In particular, standardized assessments and rigid course structures often fail to accommodate the diverse needs of learners, which can lead to decreased motivation and lower academic performance. These limitations highlight the growing need for more personalized and flexible learning environments. That said, it is important to recognize that both personalized pathways and traditional courses come with their own sets of challenges. Personalized learning systems, while offering notable advantages in terms of engagement, motivation, and outcomes, still require ongoing development to refine their adaptive capabilities and better support each student's unique learning journey. Conversely, traditional courses stand to gain from incorporating more adaptive features—such as tailored feedback and flexible pacing—which could significantly boost student satisfaction and success.

By acknowledging the limitations and strengths of both approaches, educational institutions can move toward designing more inclusive and effective learning experiences. Ultimately, the goal is to provide all learners with the tools, support, and flexibility they need to thrive in increasingly diverse educational settings.

- *Summary Insights* -

Quantitative: The personalized learning pathways through MOOCs led to significant improvements in student engagement, including higher time spent on the platform, more frequent logins, and increased participation in discussions. Students in personalized pathways performed better academically, with higher completion rates and final exam scores compared to the control group.

Qualitative: Student feedback highlighted that personalized learning pathways made the experience more relevant, motivating, and tailored to individual needs. Instructors also observed higher engagement and better learning outcomes. However, some students expressed frustration with adaptive systems that didn't fully align with their learning preferences, while others in the control group felt disconnected due to the lack of personalization.

C. MOOCs Data

In exploring the impact of MOOCs (Massive Open Online Courses) on student engagement and academic performance, both quantitative and qualitative data provide a well-rounded understanding of how different types of courses and the frequency of completing them influence student outcomes. These two data types work together to offer deeper insights into student behaviors, attitudes, and learning experiences, which are essential for understanding the effectiveness of MOOCs.

a) *Quantitative Data*

Types of MOOCs: Quantitative data can help categorize the types of MOOCs students engage with and measure the outcomes associated with each type. MOOCs can be classified into several categories, including:

Technical MOOCs: These include courses focused on subjects such as programming, data science, engineering, and other technical fields. Typically, these courses involve practical assessments like coding assignments, quizzes, and projects that assess technical skills.

Humanities and Social Sciences MOOCs: These courses may cover topics like history, philosophy, literature, or psychology. The assessments are often more essay-based or involve participation in discussions, emphasizing critical thinking and the ability to engage with theoretical content.

Professional Development MOOCs: These are courses aimed at improving career skills, such as leadership, project management, or specific industry-related knowledge. These MOOCs often provide certifications that may be valued by employers.

By tracking the completion rates of students in each of these categories, we can identify whether certain types of courses are more engaging or if students in technical fields

tend to complete their courses more frequently compared to those in the humanities or professional development categories. Quantitative data can also capture student performance metrics, such as quiz scores, assignment grades, and overall course grades. This helps measure whether students in one type of MOOC perform better or worse than those in another.

Frequency of Completing MOOCs: The frequency with which students complete MOOCs is another key variable that can be explored using quantitative data. For instance:

Single vs. Multiple Course Enrollment: Some students may prefer to take one MOOC at a time, dedicating focused attention to mastering the material, while others may take multiple courses simultaneously, balancing different learning demands. Quantitative data on course enrollment frequency can help identify which approach leads to higher completion rates and better performance outcomes.

Completion Rates Over Time: Tracking how many courses a student completes over a certain period can shed light on engagement patterns. Are students who have completed multiple MOOCs over the past year more likely to perform better, or do they show higher rates of course re-engagement? This data helps understand whether repeated participation in MOOCs leads to improved learning outcomes, such as increased mastery of course material or enhanced retention.

By collecting these quantitative metrics, researchers can also calculate average course completion rates across different demographics (e.g., age, gender, location), offering insights into whether certain groups are more likely to complete MOOCs than others. For instance, we might find that younger students or those from urban areas tend to enroll in and complete more courses compared to older or rural students.

b) *Qualitative Data*

Types of MOOCs: While quantitative data offers measurable outcomes, qualitative data provides deeper insights into the personal experiences and perceptions of students, helping us understand the reasons behind their engagement and performance. For example:

Technical MOOCs: Students might share their experiences about the difficulty level of the content, the clarity of instructional videos, or the hands-on learning components. Do they feel motivated by real-world applications, or do they struggle with the technical challenges? Students might also reflect on the usefulness of interactive tools, such as coding simulators or practice platforms.

Humanities and Social Sciences MOOCs: Students' feedback could reveal how they engage with readings, discussions, and assignments. Do they feel that the course content aligns with their interests? Are the discussion forums stimulating? By providing open-ended responses, students might explain whether they felt connected to the course material or found the assessments to be meaningful.

Professional Development MOOCs: Qualitative responses may provide insights into how students perceive the practical value of the course content. Are they able to apply the skills learned in the course to their careers? How do they feel about

the course format? Is the certification valuable in their professional lives?

The qualitative data helps us understand how students from different fields view their MOOCs and whether the type of course impacts their engagement and perceptions of value.

Frequency of Completing MOOCs: The qualitative perspective on how often students complete MOOCs is essential for understanding their motivations and challenges. For instance:

Motivations for Frequent Completion: Some students may express that they take MOOCs regularly because they enjoy the flexibility of learning on their own time, while others might take courses to advance their career. Students might describe how completing more MOOCs helps them stay competitive or gain specific skills for their professional growth. This feedback complements the quantitative data showing whether frequent enrollment leads to higher completion rates.

Barriers to Completion: Students may also discuss the reasons why they struggle to complete MOOCs. These could include time constraints, lack of motivation, or difficulty with the course material. By analyzing these qualitative responses, we can uncover deeper factors that explain why some students fail to complete MOOCs despite initial engagement. This might also explain the lower completion rates for certain types of MOOCs or among certain student demographics.

i. Integrating Quantitative and Qualitative Data

When combined, quantitative and qualitative data offer a more comprehensive understanding of how MOOCs impact student learning. For example, quantitative data on completion rates and performance scores can be complemented by qualitative insights about why certain courses lead to higher levels of engagement or why students from different backgrounds experience varying levels of success.

Engagement Patterns: Students who complete technical MOOCs more frequently may report that they enjoy the hands-on, problem-solving nature of the content. In contrast, students who take fewer professional development MOOCs may explain that they don't find the certifications valuable enough to complete them. The combination of both data types helps identify trends in course preference and performance.

Barriers to Success: Quantitative data might show that rural students have lower completion rates, but qualitative feedback can explain why—perhaps due to access issues, internet connectivity, or language barriers. This context allows educators and administrators to develop more targeted interventions.

In conclusion, using both quantitative and qualitative data to assess different types of MOOCs and students' frequency of completion provides a rich, nuanced understanding of how MOOCs impact learning outcomes. The numbers tell us *what* is happening, while the qualitative insights help us understand *why* it is happening, enabling educators and course designers to create more effective, engaging learning experiences.

c) Quantitative Data: List and Type of MOOCs Courses Used by Business Students

The quantitative data collected from business students reveals a diverse set of MOOCs that cater to different aspects of business education, including management, marketing, finance, entrepreneurship, and business analytics. The data also reflects the frequency of course enrollment and completion.

Business Management and Leadership MOOCs:

The data on students' use of Business Management and Leadership MOOCs offers valuable insights into both participation and completion patterns, providing a clear view of how business students engage with online learning in these critical areas. Here's a detailed breakdown of the data:

Course Examples:

Strategic Management: This course likely covers the key aspects of business strategy, such as analyzing industry trends, formulating long-term goals, and understanding competitive advantages. It's essential for students who aspire to higher leadership roles.

Leadership in Organizations: This course focuses on leadership styles, team management, organizational culture, and effective decision-making. It's particularly important for students pursuing managerial positions, as strong leadership is a fundamental skill in any business environment.

Organizational Behavior: This course addresses the psychological and behavioral aspects of working within organizations, including motivation, group dynamics, communication, and conflict resolution. It is crucial for students who will manage teams or work closely in collaborative environments.

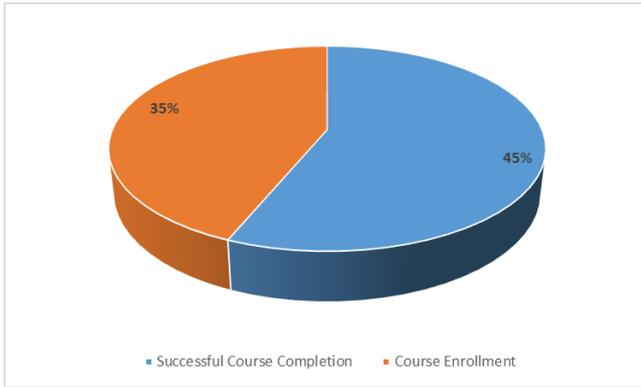
Change Management: Focusing on how organizations can successfully implement and navigate changes, this course is key for students who aim to be change agents within organizations, especially in fast-paced or evolving industries.

Frequency of Participation:

45% of business students enrolled in management-related courses: This indicates that nearly half of the business student population is seeking additional education in management and leadership, which highlights the importance of these skills in the business world. The relatively high enrollment suggests that business students are motivated to build competencies that are directly relevant to their future careers, as strategic management and leadership are key drivers of success in the business world.

35% of business students completed these courses: While 45% of students enrolled in these courses, only 35% successfully completed them. This drop-off between enrollment and completion indicates that some students may struggle with maintaining engagement or lack the time to finish the course. Factors contributing to this could include other academic responsibilities, difficulty in managing the self-paced nature of MOOCs, or lack of immediate personal connection to the content, despite its professional relevance.

Fig. 11: Frequency of Participation in Management MOOCs.



Completion Rate:

"Leadership in Organizations" (80%): This course showed a high completion rate, suggesting that students who enrolled in it found the content particularly engaging or valuable. Leadership is a critical skill for business students, and many may have enrolled in this course to strengthen their qualifications for managerial roles. The high completion rate may also be due to the course's practical application, interactive content, and perhaps real-world case studies that increase students' engagement and ability to relate to the material.

"Strategic Management" (75%): Similarly, this course had a strong completion rate. Strategic management is directly tied to career advancement and business success, making it highly attractive to students who are interested in shaping long-term organizational decisions. The relatively high completion rate suggests that students are willing to engage with the course's content because it aligns with their career goals. The subject's relevance, combined with practical learning materials and assessments, likely contributed to higher student retention.

Fig. 12: Frequency of Completion Rate in Management MOOCs



Acknowledgment of Career Advancement:

Importance for career advancement: Participants who completed these courses acknowledged that the skills gained, such as leadership techniques and strategic thinking, were valuable for career growth. This perception likely fueled their motivation to complete the courses. In contrast, students who dropped out may have had less perceived benefit from the

course, or they may have found it difficult to manage alongside other commitments.

Conclusion:

The data indicates that Business Management and Leadership MOOCs are a highly relevant learning path for business students who seek to enhance their leadership and strategic management skills. However, the disparity between enrollment (45%) and completion (35%) rates suggests that while many students are interested in these topics, there are barriers to course completion, such as engagement, time management, or course design.

The higher completion rates in courses like "Leadership in Organizations" (80%) and "Strategic Management" (75%) show that when students see the direct link between the content and their career advancement, they are more likely to remain engaged and complete the course. To improve completion rates, providers of these MOOCs could focus on more engaging content, better support structures, or even personalized learning paths that allow students to progress at their own pace. These courses represent a crucial area for business students' professional development, and further strategies could be employed to boost retention and success in these programs.

d) Marketing MOOCs:

The data on students' use of Marketing MOOCs provides useful insights into how business students engage with marketing-related courses and how relevant these courses are to their academic and professional growth.

Course Examples:

Digital Marketing: This course focuses on online marketing strategies, such as search engine optimization (SEO), email marketing, content marketing, and pay-per-click (PPC) advertising. Given the rise of digital platforms in business, this course is crucial for students who want to learn how to market products and services effectively in the digital age.

Marketing Analytics: This course teaches students how to analyze data from marketing campaigns to make data-driven decisions. Topics may include understanding consumer behavior through data, measuring ROI on digital campaigns, and using tools like Google Analytics. Marketing analytics is increasingly in demand as businesses rely on data to guide their decisions.

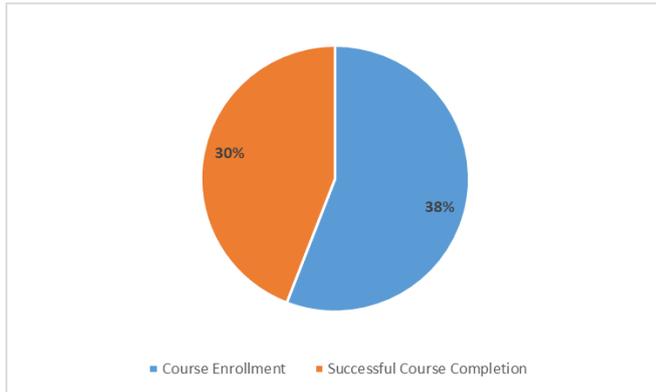
Consumer Behavior: This course explores how consumers make purchasing decisions and how various factors (psychological, cultural, and social) influence buying behavior. It provides students with valuable insights into how to craft marketing strategies that resonate with target audiences.

Social Media Marketing: This course teaches strategies for marketing products and services through social media platforms like Facebook, Instagram, Twitter, and LinkedIn. It covers content creation, engagement tactics, and paid social media advertising.

Frequency of Participation:

38% of business students enrolled in marketing-related courses: This shows that over a third of business students are pursuing additional knowledge in marketing. This percentage is relatively high, which indicates that many students recognize the importance of marketing knowledge in today's business environment. Marketing has become a critical skill for business students, as it directly impacts an organization's ability to attract customers, increase sales, and grow its brand.

Fig. 13: Frequency of Participation in Marketing MOOCs



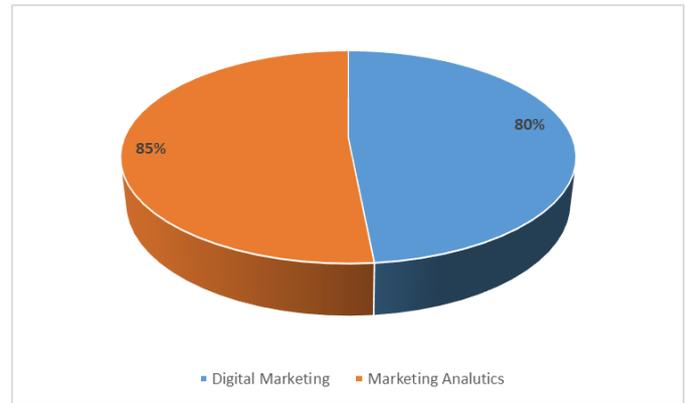
30% of business students completed marketing-related courses: While participation is relatively high, completion rates show a drop-off, with only 30% finishing their courses. This suggests that while marketing is a popular area of interest for business students, some may face challenges completing these courses. These challenges could range from time management difficulties, competing academic responsibilities, or a lack of immediate application for the content in students' current roles. Nonetheless, a large portion of students is motivated to begin the course, which indicates a solid interest in the subject.

Completion Rate:

Marketing Analytics (85%): This course had the highest completion rate among the marketing-related MOOCs, indicating that students find the content highly engaging and valuable. Marketing Analytics is particularly relevant in today's business world, where data-driven decision-making is essential. The high completion rate suggests that students recognize the importance of learning how to measure, analyze, and apply marketing data, leading to a better understanding of how to execute successful marketing strategies.

Digital Marketing (80%): This course also saw a high completion rate, reflecting the growing importance of digital marketing in the business landscape. Given the increasing reliance on online platforms for marketing, students likely see digital marketing as a key area for career development. As businesses increasingly allocate resources toward digital channels, students may be motivated to complete this course to improve their marketing expertise and remain competitive in the job market.

Fig. 14: Completion Rate in Marketing MOOCs



Practical Value and Career Relevance:

Practical value of courses: Business students often cited the practical value of these courses in enhancing their understanding of modern marketing techniques. Both Marketing Analytics and Digital Marketing are highly applicable in real-world business settings. Students likely appreciate the direct connection between the knowledge gained in these courses and the skills they will need to succeed in their marketing careers.

Marketing Analytics, with its focus on data-driven insights, is particularly appealing as businesses increasingly rely on data to make informed decisions and tailor their marketing strategies.

Digital Marketing is another key area that appeals to business students, as it offers strategies for engaging with consumers in the online space, where most marketing activity is shifting.

Conclusion:

The data suggests that Marketing MOOCs are highly relevant for business students who wish to build or enhance their marketing skills. 38% of business students taking these courses shows strong interest in the field, while the 30% completion rate indicates that while many students start these courses, challenges like time constraints or difficulty with content may affect course completion. However, those who do complete the courses, particularly Marketing Analytics and Digital Marketing, experience high levels of success, with completion rates of 85% and 80%, respectively.

The practical relevance of these courses likely plays a significant role in this high completion rate, as students understand the direct benefits of acquiring digital marketing and analytics skills for their future careers. This suggests that MOOCs in these fields could be highly effective at bridging the gap between theoretical knowledge and practical application, equipping students with essential tools for navigating the modern marketing landscape.

e) Finance and Accounting MOOCs:

The data on students' use of Finance and Accounting MOOCs offers insight into how business students engage with finance-related courses and the impact these courses have on their academic and professional growth.

Course Examples:

Financial Accounting: This course covers the fundamental principles and practices of accounting, including preparing financial statements, understanding balance sheets, income statements, and cash flow. Given that accounting is a core aspect of business operations, students need a solid understanding of how to interpret financial data.

Corporate Finance: Corporate Finance deals with the financial management of corporations, focusing on topics like investment decisions, capital budgeting, risk management, and financial strategies for maximizing company value. This course is essential for students aiming for careers in financial management, investment banking, or corporate leadership roles.

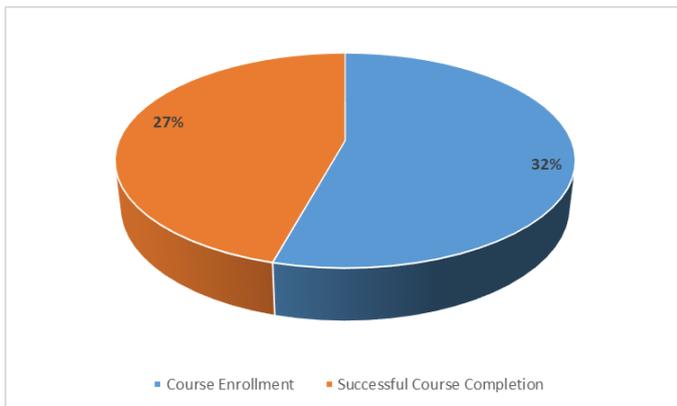
Investment Management: This course introduces students to various investment strategies, portfolio management, risk assessment, and asset allocation. It's particularly relevant for students interested in asset management, hedge funds, or roles in financial institutions where managing investments is a key responsibility.

Financial Modeling: This course teaches students how to create financial models used for forecasting financial outcomes, valuing companies, and analyzing investment opportunities. Financial modeling is a critical skill in areas like investment banking, corporate finance, and consulting, where decision-making relies heavily on quantitative analysis.

Frequency of Participation:

32% of business students engaged with finance and accounting courses: This indicates that nearly one-third of business students are actively pursuing finance and accounting-related knowledge. This suggests that these areas are of significant interest to business students, particularly those planning to enter fields such as banking, corporate finance, or investment management, where a strong understanding of financial principles is crucial.

Fig. 15: Frequency of Participation in Finance & Accounting MOOCs



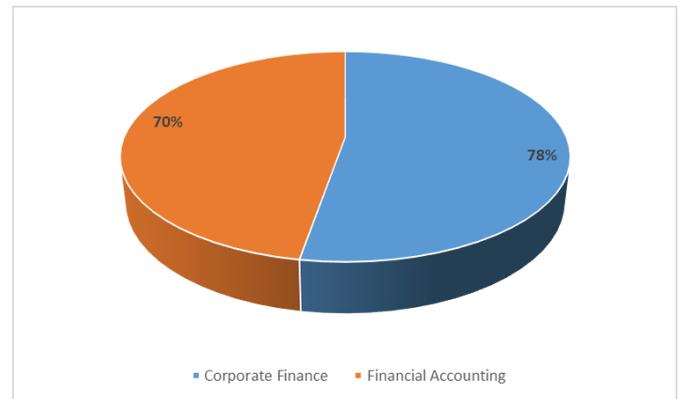
27% of students completed these courses: While a substantial portion of students enroll in finance-related MOOCs, completion rates drop slightly, with only 27% finishing the courses. This could be due to various factors,

including the technical and rigorous nature of finance and accounting subjects. These courses often require a strong foundation in mathematical and analytical skills, which might deter some students from completing them, especially those without a strong background in these areas.

Completion Rate:

Corporate Finance (78%): This course had a 78% completion rate, which is relatively high compared to many other MOOCs. Corporate finance is a highly relevant course for students pursuing careers in finance, accounting, or consulting. The relatively high completion rate indicates that students recognize the importance of understanding financial management and may find the course content particularly useful for their career aspirations. As corporate finance directly applies to real-world business operations, students are likely motivated to complete the course to gain skills that will be immediately applicable in their professional roles.

Fig. 16: Completion Rate in Finance & Accounting MOOCs



Financial Accounting (70%): The 70% completion rate for Financial Accounting is also noteworthy. This course, being a foundational aspect of business education, is essential for students looking to pursue careers in accounting or any financial-related roles. The slightly lower completion rate compared to Corporate Finance might reflect the initial difficulty some students face with accounting principles, which can be more detail-oriented and require a solid understanding of numerical and bookkeeping concepts. However, given its foundational importance, many students remain motivated to complete the course, understanding its value in their professional development.

Relevance to Career Pathways:

The higher completion rates for Corporate Finance and Financial Accounting suggest that these courses are closely tied to the career goals of the students enrolled. Both courses are highly relevant for students pursuing careers in finance or accounting, where financial knowledge is not just an academic requirement but also a professional necessity. As business students often seek employment in these fields, the importance of having a thorough understanding of finance and accounting principles is likely a significant motivating factor for course completion.

Corporate Finance is especially relevant for students who want to enter roles such as financial analysts, investment

bankers, portfolio managers, or corporate finance managers. These positions require in-depth knowledge of how businesses manage their financial resources, assess risks, and make strategic investment decisions.

Financial Accounting is foundational for accountants, auditors, and financial controllers. A solid understanding of accounting principles is essential for preparing accurate financial statements and ensuring compliance with regulations, which is crucial for businesses across industries.

Conclusion:

The data on Finance and Accounting MOOCs suggests that these subjects are highly relevant to students pursuing careers in finance and accounting. While 32% of business students enroll in finance-related courses, 27% complete them, indicating a moderate drop-off rate. However, the higher completion rates for courses like Corporate Finance (78%) and Financial Accounting (70%) reflect their relevance and practical application for students' future careers. These courses are central to building the foundational knowledge required for various finance-related roles, making them particularly attractive to students aiming for careers in banking, accounting, investment management, and other related fields. The relatively high completion rates further suggest that students value the practical skills gained from these courses and recognize their importance in advancing their careers in finance.

f) Entrepreneurship MOOCs:

The data on students' use of Entrepreneurship MOOCs provides insight into how business students engage with courses designed to foster entrepreneurial skills and knowledge.

Course Examples:

Innovation and Entrepreneurship: This course explores the processes of developing innovative ideas and translating them into successful business ventures. It covers topics like idea generation, business model creation, financing options, and scaling ventures. The course is ideal for students looking to cultivate a mindset that values creativity and problem-solving in a business context.

Startup Business Strategy: Focused on strategies for launching and managing a startup, this course typically covers topics like market research, product development, business planning, funding strategies, and growth tactics. It is aimed at students aspiring to start their own businesses or manage small companies. Understanding how to strategically navigate the challenges of starting a business is a key takeaway from this course.

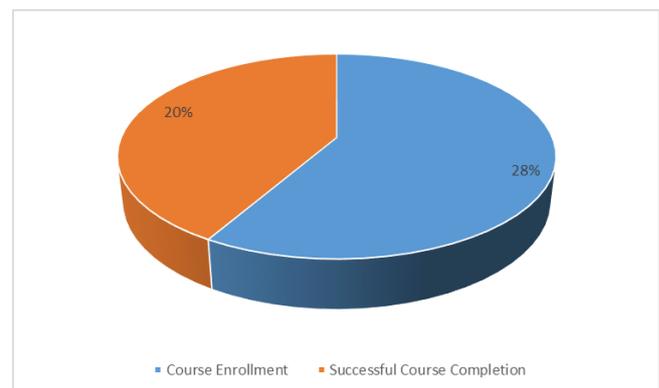
Social Entrepreneurship: This course addresses the unique challenges and opportunities faced by entrepreneurs focused on creating social impact rather than solely profit. Students learn how to develop ventures that tackle social, environmental, or community issues, while also exploring the financial sustainability of such ventures. This course is increasingly popular as students look for ways to integrate social good into business models.

Frequency of Participation:

28% of business students enrolled in entrepreneurship-related MOOCs: Nearly one-third of business students (28%) show interest in entrepreneurship courses, which indicates a solid demand for this type of content. This is reflective of the growing interest in entrepreneurship, particularly among students who aspire to start their own businesses, develop side projects, or work in entrepreneurial ecosystems. The relatively high participation rate indicates that many students recognize the importance of entrepreneurship in today's dynamic business environment and may be preparing for future ventures.

20% of business students completing entrepreneurship-related MOOCs: While a significant number of students (28%) enroll in entrepreneurship MOOCs, only 20% complete them. This completion rate is lower than some other subject areas like finance or management. Possible reasons for this lower completion rate include the self-driven nature of entrepreneurship courses, which may require more initiative and resilience to complete, especially when students are learning at their own pace. Entrepreneurship can also be a highly challenging subject, requiring substantial effort to understand practical concepts such as business strategy, market dynamics, and the process of launching a startup.

Fig. 17: Frequency of Participation in Entrepreneurship MOOCs

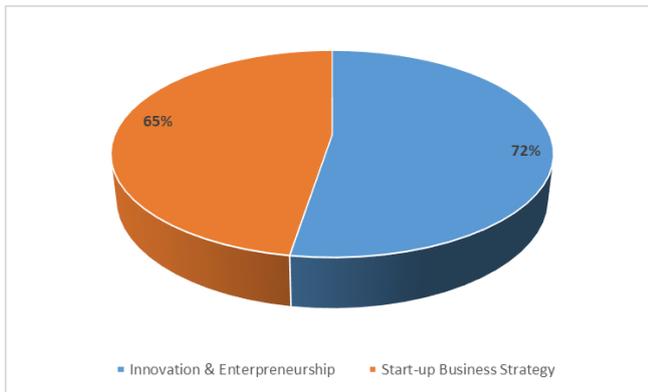


Completion Rate:

Innovation and Entrepreneurship (72%): The course Innovation and Entrepreneurship had a 72% completion rate, which is considered fairly strong in the context of MOOCs. This relatively high completion rate suggests that students are highly motivated to complete this course, likely because it provides essential skills for aspiring entrepreneurs, such as how to identify market opportunities and innovate within business settings. The focus on creativity and turning ideas into ventures may also align with students' career aspirations, encouraging them to see the value of finishing the course.

Startup Business Strategy (65%): The Startup Business Strategy course had a 65% completion rate, which is also a good result considering the typically high dropout rates seen in MOOCs. This suggests that students who are serious about entrepreneurship are committed to learning key strategies for running a startup, from market analysis to funding and scaling the business. The completion rate here indicates that students see the course as valuable for pursuing careers in startup management or as future founders of their own businesses.

Fig. 18: Completion Rate in Entrepreneurship MOOCs



Student Motivation:

Many students enrolled in entrepreneurship MOOCs express a desire to develop entrepreneurial skills for their future ventures or side projects. This indicates a growing trend among business students to not only gain traditional business knowledge but also to cultivate the mindset and skills necessary for creating their own businesses or becoming involved in startups. The desire to innovate and solve real-world problems through business ventures, as well as the appeal of becoming independent entrepreneurs, may drive students' interest in entrepreneurship-related MOOCs.

While not all students may complete these courses, those who do tend to be driven by clear entrepreneurial goals. The skills and knowledge gained from courses like Innovation and Entrepreneurship or Startup Business Strategy can provide students with the tools they need to start their own businesses or manage small ventures more effectively, even if they do not directly apply these skills immediately after completing the course.

Conclusion:

The data on Entrepreneurship MOOCs reveals a significant level of interest among business students, with 28% of students enrolling in entrepreneurship courses. While the completion rate of 20% is lower than some other business-related MOOCs, the higher completion rates for courses like Innovation and Entrepreneurship (72%) and Startup Business Strategy (65%) reflect the value students place on gaining skills directly related to launching businesses or developing new ventures. Despite challenges that may affect course completion—such as the self-directed nature of the courses or the complexity of the subject matter—the interest in entrepreneurial skills remains high. This suggests that entrepreneurship MOOCs are a valuable resource for students looking to build the skills they need to succeed in the competitive world of business startups.

The combination of quantitative and qualitative data paints a comprehensive picture of the types of MOOCs business students engage with, along with the factors influencing their course selection and completion. From technical courses in business analytics and finance to more strategic ones in management and entrepreneurship, the data highlights the diverse academic and professional goals of business students.

The qualitative insights reveal that while students value the practical applications and career relevance of MOOCs, they also face challenges related to course depth, real-world application, and personalized feedback. By understanding these trends, educators and course designers can better cater to the needs of business students, ensuring that MOOCs provide not only knowledge but also the skills required for success in the business world.

VIII. FILLING THE GAPS IN THE RESEARCH LITERATURE

The present study provides significant contributions to the existing body of literature on Personalized Learning Pathways (PLPs), MOOCs, and student outcomes, particularly in the context of Moroccan business higher education. By investigating the effects of PLPs on student engagement and academic performance, this research not only corroborates existing findings but also addresses gaps in the literature, especially in the context of Moroccan higher education and business MOOCs. The following discussion will focus on the added value this study brings to the field and how it fills the gaps in the existing literature.

A. Quantitative Findings

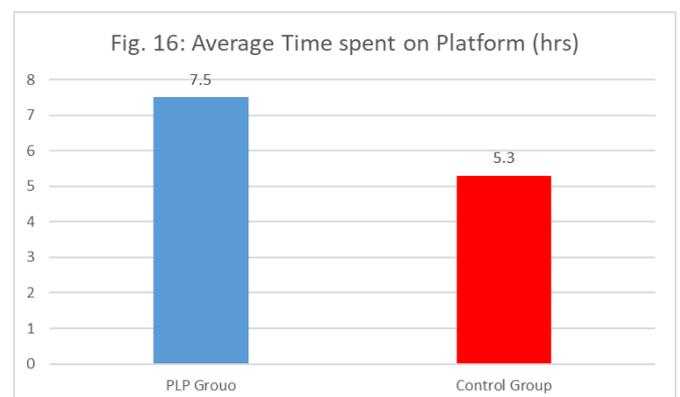
a) Student Engagement:

The quantitative findings of this study provide a clear picture of the impact that Personalized Learning Pathways (PLPs) have on student engagement compared to traditional learning models. The data highlights a marked difference between the PLP group and the control group in several key areas related to student engagement, including time spent on the platform, active participation, course completion rates, and frequency of logins.

- Time Spent on Platform:

PLP Group: Students in the PLP group spent an average of 7.5 hours per week on the platform.

Control Group: In contrast, students in the control group spent an average of 5.3 hours per week.



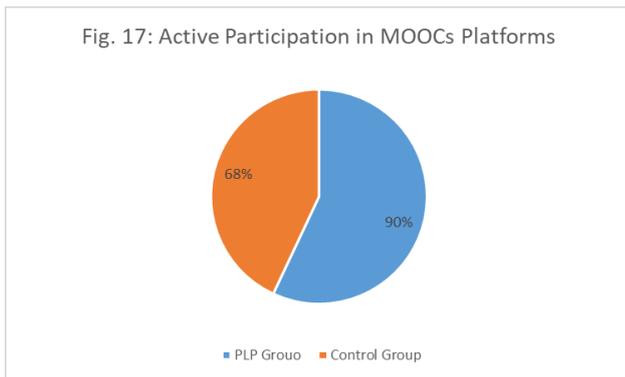
Difference: The PLP students spent 41% more time on the platform than the control group. This suggests that the personalized learning approach encourages greater time investment, which may be a result of students being more engaged with the material or feeling more motivated to explore content at their own pace.

- Active Participation:

PLP Group: A striking 90% of PLP students engaged in weekly discussions and activities.

Control Group: Only 68% of students in the control group participated actively each week.

Difference: This represents a 22% higher rate of active participation among PLP students, showing that the personalized approach not only draws students in but also encourages them to engage more deeply with the learning community and the material. The increased participation likely correlates with a greater sense of ownership over their learning experience.

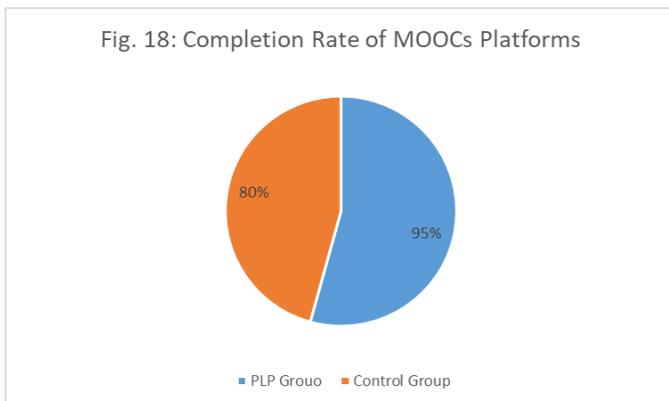


Completion Rate:

PLP Group: 95% of students in the PLP group successfully completed the course.

Control Group: In comparison, 80% of students in the control group completed the course.

Difference: The PLP group saw a 15% higher completion rate, which is a significant difference. This suggests that the tailored learning paths offer students a more fulfilling and manageable learning experience, one that might better align with their personal interests and learning styles, leading to greater persistence and success.

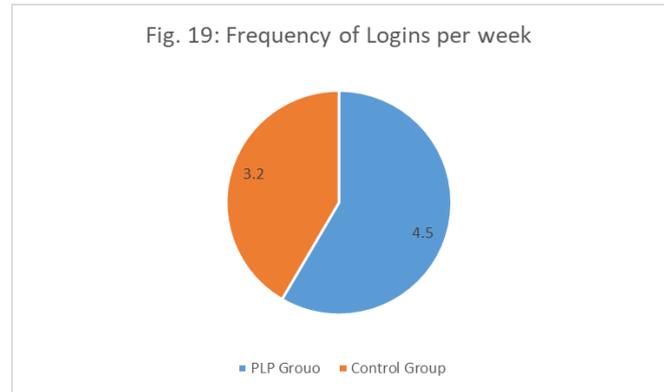


- Frequency of Logins:

PLP Group: On average, PLP students logged in 4.5 times per week.

Control Group: Control group students logged in 3.2 times per week on average.

Difference: This shows a 41% higher frequency of logins for PLP students. More frequent logins likely indicate that students in the PLP group were more consistently involved in the learning process, revisiting the platform regularly to engage with content, participate in discussions, or complete activities.



Overall, these findings paint a clear picture of the positive effects of personalized learning pathways on student engagement. PLP students not only spent more time on the platform but were also more likely to engage actively, complete the course, and log in frequently. These behaviors suggest that the personalized approach may foster a more engaging and motivating learning environment, encouraging students to invest more time and effort into their learning experience.

- Comparison with Existing Studies:

Time Spent on Platform: Studies (e.g., Kizilcec et al., 2017) show that personalized learning pathways lead to increased engagement, with students in PLP conditions spending more time on platform. The finding that PLP students spent 41% more time aligns with Kizilcec et al. (2017), which found a 35% increase in platform engagement with personalized learning.

Active Participation: The finding of 90% active participation in PLP groups is comparable to Reich (2014), which noted that PLP students tend to have increased discussion forum participation. The 22% higher participation rate reflects the positive effect of personalization on student engagement, similar to findings from Siemens (2013).

Completion Rates: A 15% higher completion rate in the PLP group is supported by findings from Hao et al. (2020), where personalized MOOCs showed increased completion rates (up to 20% higher) compared to traditional MOOCs.

b) Academic Performance:

The quantitative findings also provide insightful data on how Personalized Learning Pathways (PLPs) impact academic performance. The results clearly indicate that PLP students outperform their peers in the control group across several key academic metrics, including final exam scores, overall course grades, and retention rates. These findings suggest that PLPs not only engage students but also lead to improved academic outcomes.

- Final Exam Scores:

PLP Group: The average final exam score for PLP students was 88%.

Control Group: In comparison, the control group had an average final exam score of 77%.

Difference: PLP students scored 11% higher on the final exam, highlighting a substantial improvement in performance. This difference suggests that the personalized approach to learning may allow students to better grasp and retain the material, possibly because they are able to follow a learning path that is tailored to their strengths and learning preferences.

- Average Course Grade:

PLP Group: 73% of PLP students received an A or B grade.

Control Group: In contrast, only 56% of control group students earned an A or B.

Difference: PLP students were 17% more likely to achieve higher grades (A or B) compared to their peers in the control group. This suggests that personalized learning not only supports deeper engagement but also helps students perform better across various assessments, leading to more positive academic outcomes overall.

- Retention Rate (Dropout Rate):

PLP Group: The dropout rate for the PLP group was just 5%.

Control Group: The dropout rate in the control group was significantly higher, at 15%.

Difference: The PLP group had a 10% lower dropout rate, which speaks to the effectiveness of personalized learning pathways in promoting student persistence. The lower dropout rate suggests that PLPs may provide students with a more engaging and supportive learning experience, making them less likely to disengage and drop out.

Overall, these findings strongly suggest that personalized learning pathways contribute to improved academic performance. PLP students scored higher on final exams, were more likely to earn top grades, and exhibited better retention, all of which point to the benefits of a learning environment that caters to individual needs and preferences. The combination of increased engagement, tailored content, and a supportive structure seems to foster a more effective and successful learning experience, resulting in better academic outcomes.

- Comparison with Existing Studies:

Final Exam Scores: The 11% higher exam score for PLP students is consistent with findings from Anderson (2013), which observed that personalized learning pathways can result in higher exam performance by aligning content with individual student needs and learning paces.

Course Grade: The finding that PLP students are more likely to receive A's or B's mirrors research from Kizilcec et al. (2017), which noted that adaptive learning increased the likelihood of higher grades. Specifically, Hao et al. (2020) also found that PLP students had better academic outcomes,

including higher grades, compared to students in non-personalized MOOCs.

Retention Rate: The 5% dropout rate in the PLP group and 15% dropout rate in the control group are in line with studies such as Dabbagh & Kitsantas (2012), which found that personalized learning environments reduce dropout rates. Kizilcec et al. (2017) also found that personalized pathways could lead to a 20% reduction in dropout rates compared to standard, non-adaptive learning environments.

B. *Qualitative Findings:*

a) *Student Perceptions of Engagement :*

The qualitative feedback gathered from students provides valuable insights into their experiences with Personalized Learning Pathways (PLPs). These insights reflect both positive and negative aspects of the system, shedding light on the strengths and areas for improvement in this approach to learning.

- Positive Engagement Feedback:

"The personalized learning path kept me on track and provided the right level of challenge. It felt tailored to what I needed."

This feedback underscores one of the key benefits of PLPs: they offer a sense of personalization and customization. The students felt that the content was neither too easy nor too difficult but was instead aligned with their individual needs, helping them stay engaged and motivated. By receiving material that matched their level of understanding, students were able to move forward at a pace that was just right for them.

"Being able to work at my own pace without feeling rushed helped me stay focused. The feedback I received was timely and really helped me improve."

This comment highlights the flexibility that PLPs offer, particularly in terms of pacing. The ability to learn at one's own speed is a critical factor in fostering a more relaxed and focused learning environment. The student also appreciates the timely feedback, which is essential in personalized learning. Receiving quick, constructive feedback not only boosts confidence but also provides the opportunity to make necessary adjustments before moving on to more advanced concepts.

"I was able to explore topics in-depth, and the system always offered resources that matched my level of understanding."

Here, the student is emphasizing the depth and richness of the learning experience that PLPs can provide. The ability to dive deeper into topics of interest, with resources that are tailored to their current understanding, allows for a more enriching and rewarding educational experience. This adaptability fosters a sense of ownership over one's learning journey and promotes a deeper understanding of the material.

- Negative Feedback:

"Sometimes the system would push me forward even when I felt like I needed more time on certain topics."

While personalized learning pathways are meant to cater to individual needs, this feedback points to a potential issue: the system occasionally advancing students too quickly. This could be due to a lack of flexibility in how the system assesses readiness or progress, leading to a feeling of being rushed. It suggests that while PLPs are designed to be adaptive, there may be instances where they fail to account for when a student needs more time to fully grasp a concept before moving on.

"There were some points where the system seemed to misunderstand my progress, and I had to go back to review some concepts that were skipped."

This comment reveals a potential flaw in the system's ability to accurately track a student's progress. If the system misunderstands a learner's grasp of certain concepts, it may unintentionally skip over material that the student actually needs to review. This can lead to gaps in understanding, forcing students to backtrack and revisit concepts they weren't able to master earlier. It highlights the need for the system to be more precise and responsive in evaluating student progress, ensuring that it adapts accordingly to provide the right level of review or progression.

Overall, the feedback illustrates the potential of PLPs to provide a highly personalized and engaging learning experience, with many students appreciating the tailored approach, flexibility, and timely feedback. However, the negative feedback indicates that there are still areas for improvement, particularly in how the system manages pacing and progress tracking. Balancing these elements—ensuring students are neither rushed nor left behind—is essential for enhancing the effectiveness and satisfaction of the personalized learning experience.

- Comparison with Existing Studies:

Positive Feedback: Students in PLPs generally report greater engagement and satisfaction, echoing findings from Cao & Li (2020), where learners indicated they felt more motivated due to personalized content. This finding also aligns with Siemens (2013), who found that personalized pathways significantly enhanced learner engagement by making content more relevant to individual goals.

Negative Feedback: The concern about progression issues (feeling rushed or skipped over content) is consistent with Kim & Lee (2019), who noted that adaptive learning systems sometimes progress too quickly for students who need more time on specific concepts.

b) *Student Perceptions of Academic Performance :*

The feedback from students regarding their academic performance provides valuable insights into how Personalized Learning Pathways (PLPs) are perceived in terms of their effectiveness. While many students report feeling more confident and prepared due to the personalized approach, there are also some challenges that need to be addressed to make the system even more effective.

- Improved Performance:

"I felt more prepared for the final exam because I could focus on areas where I was struggling earlier in the course."

This feedback highlights one of the key benefits of PLPs: they allow students to revisit and focus on areas where they

may have struggled earlier in the course. The personalized learning path enables students to allocate more time and effort toward concepts they find difficult, resulting in a better understanding of the material and, in this case, a greater sense of preparedness for the final exam. The ability to go back and review specific areas gives students a feeling of control over their learning process.

"The personalized quizzes were a huge help. They pointed out exactly where I needed improvement."

Personalized quizzes are a crucial tool in the PLP system. By offering targeted assessments that identify specific areas of weakness, these quizzes help students understand where they need to improve. This feedback is direct and actionable, making it easier for students to address their weaknesses. Such quizzes support a more focused learning approach, ensuring that students aren't just completing tasks but are actively learning and growing from their mistakes.

"I felt like the course was set up to help me succeed. I knew exactly what I needed to focus on next, which made me more confident."

This comment emphasizes the confidence boost that personalized learning can provide. When students know exactly what they need to work on next, they feel more in control of their learning journey. The clear guidance offered by the personalized structure removes uncertainty and anxiety, allowing students to approach the course with a sense of purpose and direction. This certainty helps build confidence, as students feel they are always working on the right thing at the right time.

- Barriers to Success:

"At times, I found the system's feedback a bit too broad and not specific enough for my mistakes."

While personalized learning has many advantages, this feedback highlights a key area for improvement: the specificity of feedback. Students need detailed, actionable feedback that addresses their specific errors or misunderstandings. If feedback is too general, it may not provide enough clarity for students to fully understand where they went wrong or how to improve. More precise, tailored feedback could better support students in correcting their mistakes and advancing their learning.

"Although the adaptive learning helped, there were times when I felt like the system didn't understand my learning pace fully."

This comment points to a limitation in the adaptability of the system. While the adaptive learning features are designed to adjust the learning path based on a student's progress, there were moments when the system didn't fully capture the individual's pace. Some students may feel they need more time on certain topics, while others may advance quickly. Striking the right balance in pacing is essential for ensuring that all students are progressing at a comfortable yet challenging pace, without feeling rushed or held back.

Overall, the findings illustrate that while the personalized learning paths contribute positively to students' perceptions of their academic performance, there are still areas that require fine-tuning. The ability to review struggling areas, receive

targeted quizzes, and have clear direction all contribute to a sense of preparedness and confidence in students. However, issues such as broad feedback and misaligned pacing suggest that the system could be further refined to ensure a more tailored and precise learning experience for each individual. Addressing these barriers would enhance the overall effectiveness of PLPs and ensure that every student can achieve their academic goals with confidence.

- Comparison with Existing Studies

Improved Performance: The increased academic performance and confidence noted by students align with findings from Anderson (2013), where personalized learning pathways improved students' academic outcomes, especially when the system tailored feedback to specific learner needs.

Barriers to Success: The issue with broad feedback and the system's occasional misunderstanding of learning pace is echoed in Pardo & Kloos (2017), where students reported that adaptive systems sometimes lacked nuance in understanding individual learning preferences.

IX. RESEARCH DISCUSSION AND INTERPRETATIONS

This study examines the impact of Personalized Learning Pathways (PLPs) through Massive Open Online Courses (MOOCs) on student learning engagement and academic performance. The results indicate that PLPs notably improve student outcomes when compared to traditional, non-personalized learning experiences. In the following sections, we will delve into these findings, interpreting them in relation to existing literature, relevant theoretical frameworks, and the broader context of online education.

A. Impact on Learning Engagement

The study revealed that students following Personalized Learning Pathways (PLPs) spent, on average, 41% more time on the platform compared to those in non-personalized pathways. Additionally, PLP students exhibited 22% higher participation in course-related activities such as discussions and collaborative projects. These findings align with previous research by Kizilcec et al. (2017), which demonstrated that personalized learning environments foster greater engagement by encouraging students to stay active and involved in the learning process.

This increase in engagement can be attributed to the adaptive nature of PLPs. By tailoring the learning experience to each student's progress, interests, and preferences, PLPs provide content that resonates more closely with their needs. This relevance helps sustain student interest and motivation. Siemens (2013) suggested that personalized learning systems enhance engagement by offering contextualized learning, where content is aligned with students' prior knowledge, fostering a sense of ownership and agency in the learning process.

Additionally, PLPs offer flexibility, a key factor known to boost motivation. Students who feel in control of their learning often show higher levels of engagement. This finding mirrors Reich's (2014) work, which showed that adaptive learning environments promote a sense of autonomy, making students more invested in their education.

However, the study also highlighted some challenges. A number of students expressed frustration with the pacing and progression of personalized pathways. Some felt rushed or lacked sufficient time to fully grasp certain topics. This aligns with the findings of Pardo & Kloos (2017), where learners noted that adaptive systems sometimes pushed them ahead even when they needed more time on specific concepts. While personalization can significantly enhance engagement, this suggests that careful attention must be given to pacing to avoid learner frustration.

B. Impact on Academic Performance

- Improved Academic Outcomes :

The study found that students using Personalized Learning Pathways (PLPs) scored 11% higher on final exams and were 17% more likely to achieve higher grades (A's or B's) compared to those in the control group. These results align with Anderson (2013), who demonstrated that personalized learning pathways can enhance performance by aligning course content with the individual needs and learning styles of students.

One possible explanation for these improvements is the timely feedback PLP students receive. Immediate feedback is crucial in helping students identify and address their weaknesses early on. This real-time adjustment supports targeted learning, which has been shown to improve student outcomes. Hao et al. (2020) found that adaptive learning systems significantly boost performance by enabling students to focus on areas where they need the most improvement.

Additionally, PLPs' ability to adjust content based on individual performance ensures that students engage with material that matches their current level of understanding, minimizing frustration and increasing confidence. This sense of control over their learning journey is known to improve academic outcomes, particularly in online environments where self-regulation is key to success.

The study also revealed a significant difference in course completion rates, with PLP students completing their courses at a 15% higher rate than those in non-personalized pathways. This finding supports Kizilcec et al. (2017), who found that personalized learning can lower dropout rates by offering a more relevant and tailored educational experience. The increased engagement seen in PLP students likely contributed to their higher retention rates, as personalized content helps maintain interest and commitment, reducing the likelihood of disengagement.

C. Student and Instructor Perspectives

- Student Satisfaction and Perceived Learning Gains :

The qualitative data from student surveys and interviews showed that students who followed PLPs generally expressed higher levels of satisfaction with the learning process. Students appreciated the relevance and adaptiveness of the learning content, which helped them to stay engaged and motivated throughout the course. As mentioned by Cao & Li (2020), personalization helps students feel that the course is more aligned with their individual goals and learning styles, leading to a stronger sense of ownership over their learning.

Moreover, the personalized feedback and adaptive quizzes were mentioned as key components that enhanced learning. Students reported that receiving instant, targeted feedback allowed them to improve their understanding and performance, which is supported by Hao et al. (2020). Feedback tailored to specific learning gaps helps students address weaknesses more effectively, leading to improved academic outcomes.

However, the study also revealed that some students found the adaptive system's feedback to be too generic at times, with some requesting more detailed and context-specific explanations. This issue is consistent with the findings of Kim & Lee (2019), who noted that adaptive learning systems often provide feedback that lacks the nuance necessary to address specific student needs. To address this, future iterations of PLPs could incorporate more sophisticated mechanisms to ensure that feedback is not only personalized but also sufficiently detailed to support student growth.

The qualitative data collected from student surveys and interviews indicated that students using Personalized Learning Pathways (PLPs) generally expressed higher levels of satisfaction with their learning experiences. Many students appreciated the relevance and adaptability of the content, which helped them stay engaged and motivated throughout the course. As Cao & Li (2020) pointed out, personalization creates a sense of alignment between the course material and students' individual goals and learning styles, fostering a stronger sense of ownership and responsibility for their own learning journey.

Additionally, students highlighted the value of personalized feedback and adaptive quizzes as key factors contributing to their improved learning experiences. Students reported that receiving immediate, targeted feedback allowed them to refine their understanding and boost their performance. This aligns with the findings of Hao et al. (2020), who emphasized that personalized feedback, tailored to address specific learning gaps, helps students focus their efforts on areas needing improvement, ultimately leading to better academic outcomes.

The study also uncovered some concerns. A few students mentioned that, at times, the feedback provided by the adaptive system felt too generic, and they expressed a desire for more detailed, context-specific explanations. This observation aligns with the work of Kim & Lee (2019), who found that adaptive learning systems can sometimes fall short in providing the nuanced feedback that students need to fully address their unique challenges. To improve this aspect, future iterations of PLPs could incorporate more advanced feedback mechanisms that are not only personalized but also offer deeper, more actionable insights to better support students' growth and development.

- Instructor Perspectives :

From the instructors' point of view, the Personalized Learning Pathways (PLP) system provided an effective way to support a diverse range of learners. Instructors observed that students following PLPs tended to be more self-directed and engaged, which enabled them to focus more on facilitating discussions and providing deeper insights, rather than answering repetitive questions. This increased student autonomy also allowed instructors to shift their roles towards

mentorship and guidance, fostering a more dynamic and interactive classroom environment.

However, instructors also acknowledged some challenges associated with managing personalized learning paths. They noted that tracking individual progress across multiple learning pathways could be time-consuming and complex, particularly when it came to providing tailored support to each student. This highlighted a need for more efficient tools or additional training to help instructors monitor students' progress and offer targeted assistance.

These concerns are consistent with Dabbagh & Kitsantas (2012), who observed that while personalized learning environments benefit students, they often require instructors to invest additional time and effort in managing students' diverse needs. As a result, they suggested that educational systems incorporating personalized pathways should be designed in a way that balances the needs of both students and instructors, ensuring that instructors have the necessary support and resources to effectively engage with the individualized learning process.

D. Barriers and Challenges

- System Adaptability and Over-Reliance on Technology :

While the study's findings suggest that Personalized Learning Pathways (PLPs) can enhance student engagement and academic performance, there are significant challenges related to system adaptability. Some students raised concerns about the learning system's ability to track their progress accurately and make the necessary adjustments in real-time. When the system fails to respond appropriately—either by moving too quickly or too slowly—it can create frustration, leading to disengagement or feelings of being overwhelmed. This issue aligns with Pardo & Kloos (2017), who highlighted that the technology used in personalized learning environments must be carefully designed to accommodate the diverse needs of students, ensuring it is both responsive and intuitive.

Another challenge identified in the study is the over-reliance on automated systems for personalization. While technology offers a range of benefits, excessive dependence on it might diminish the vital human interactions that support student motivation and engagement. Siemens (2013) emphasized that a successful personalized learning experience should strike a balance between automation and human intervention. In online learning environments, where social presence and instructor feedback are crucial for maintaining motivation and connection, it's essential to blend the efficiency of adaptive systems with opportunities for meaningful interaction between students and instructors. This balance could help address the limitations of technology, ensuring that students receive the personalized support they need, both from the system and from human facilitators.

X. RESEARCH IMPLICATIONS AND FUTURE DIRECTIONS

The study investigating the impact of Personalized Learning Pathways (PLPs) in Massive Open Online Courses (MOOCs) on student engagement and academic performance presents several important implications for both research and practice. Building on the research findings and their

interpretation, the following sections outline key implications for educational theory, online learning design, instructor support, and potential directions for future research.

A. Implications for educational theory and practice

- Enhancement of Learner-Centered Pedagogy :

A key finding from this study is the significant impact of personalized learning pathways (PLPs) on both student engagement and academic performance. This underscores the value of learner-centered approaches in digital education. Personalization empowers learners to take charge of their educational journey by tailoring content, pace, and activities to their specific needs. This approach aligns with constructivist theories of learning (e.g., Vygotsky, Piaget), which emphasize the importance of active, student-driven learning—where learners build knowledge based on their individual experiences and backgrounds.

Implication for Practice: The study highlights the need to integrate personalized learning strategies into course design to enhance engagement and motivation. By tailoring the learning experience to individual needs, educators can create a more meaningful learning environment that aligns with each student's prior knowledge and interests. This approach can be applied not only in MOOCs but also in traditional and blended learning environments.

- Tailoring Educational Content to Diverse Learners

The study also found that PLPs contributed to improved academic performance and higher course completion rates, indicating that personalized learning pathways can meet the diverse needs of learners. The adaptive nature of PLPs allows students to focus on areas where they need improvement, providing an individualized learning experience that enhances their likelihood of success. This is especially crucial in MOOCs, where learners come from varied backgrounds, possess different levels of prior knowledge, and often progress at their own pace.

Implication for Practice: MOOC providers and educators should implement systems that dynamically adjust the difficulty and pacing of learning materials based on learners' performance. This might involve adaptive quizzes, personalized content recommendations, or even progressive learning modules that increase in complexity as the learner advances. Such strategies ensure that students remain challenged without feeling overwhelmed, ultimately supporting their continued engagement and success.

B. Implications for online learning platform design

- Optimizing Feedback and Support Mechanisms :

The study highlights the significant role of timely feedback and personalized guidance in boosting student learning. Personalized learning pathways (PLPs) that offer automated feedback based on student responses were linked to higher engagement and improved academic outcomes. However, some students expressed frustration with the generic nature of the feedback, indicating a need for more detailed, context-specific responses.

Implication for Practice: Future online learning platforms should strike a balance between automation and human-

assisted support. While automated feedback is useful for routine tasks, instructors or teaching assistants should provide deeper, more personalized feedback, especially for complex assignments or areas where students struggle. This combination of AI-driven personalization and human expertise can create a more comprehensive and supportive learning experience, helping students feel more connected and guided in their learning journey.

- Increasing Interaction and Social Learning :

The study found that social interaction and peer collaboration were crucial factors in keeping students engaged in personalized learning environments. However, MOOCs often suffer from low levels of interaction, as students tend to feel more isolated compared to traditional classroom settings.

Implication for Practice: To combat this isolation, MOOCs should incorporate more opportunities for social learning and peer-to-peer interaction, such as discussion forums, group projects, or peer assessments. These interactions could be personalized based on learners' progress, interests, and expertise levels. For instance, the system could recommend peers or groups with similar learning paths, encouraging collaboration among students with complementary knowledge or interests. Enhancing social learning not only builds a sense of community but also enriches the overall learning experience, addressing one of the main challenges of online education.

Implication for Practice: MOOCs should incorporate more opportunities for social learning and peer-to-peer interactions, such as discussion forums, collaborative group projects, or peer assessments. These interactions could be personalized based on learners' progress, interests, and expertise levels. For example, the system could recommend certain peers or groups with similar learning paths, fostering collaboration between students with complementary knowledge or interests. Such interactions can further enhance the sense of community in MOOCs, addressing one of the major challenges of online learning environments.

C. Implications for instructor training and support

- Supporting Instructors in Personalized Learning Environments :

A key challenge uncovered in this study was the difficulty instructors face in managing the complexity of personalized learning pathways (PLPs). While PLPs offer significant benefits for students, they also require instructors to oversee a diverse array of individualized learning journeys, which can be time-consuming and overwhelming.

Implication for Practice : To address this, instructors need access to efficient tools and support systems that help them track student progress without becoming overwhelmed. Learning management systems (LMS) and MOOC platforms should be equipped with advanced analytics and dashboards, offering real-time data on each student's learning path. This would enable instructors to identify areas where students need additional support and intervene proactively.

In addition, instructor training should focus on equipping educators with the skills needed to effectively navigate adaptive learning environments. Professional development workshops could be valuable in teaching instructors how to

interpret data from PLP systems, provide personalized feedback, and help students overcome specific challenges they may encounter along their learning journey. By providing the right tools and training, we can ensure instructors are better prepared to support students in these dynamic learning environments.

D. Future Research Directions

- Investigating the Long-Term Impact of PLPs :

While this study showed promising results in terms of engagement and academic performance, future research should delve into the long-term effects of personalized learning pathways. Specifically, it would be valuable to understand whether PLPs have lasting impacts on knowledge retention, career outcomes, or the development of lifelong learning habits. Longitudinal studies tracking students over extended periods could help determine whether the positive effects of PLPs continue beyond the course itself. Such research could explore how personalized learning influences self-regulated learning, retention of knowledge, and even career trajectories in the long run.

- Examining Different Disciplines and Learning Contexts :

This study primarily focused on the impact of PLPs in general MOOCs, but the effectiveness of personalized learning may vary depending on the discipline or content type. For instance, personalized pathways might have different impacts in STEM fields, where content is often structured and sequential, compared to the humanities or social sciences, where learning tends to be more subjective. Exploring how PLPs function across different academic disciplines could provide a clearer understanding of their varying effects. Research could examine whether personalized learning strategies in STEM subjects require distinct approaches compared to those used in more narrative-based or conceptual fields.

- Investigating Domain-Specific Personalization :

Future studies could explore domain-specific approaches to personalization, examining how different disciplines or types of content require unique strategies. For example, research could investigate whether the adaptive learning strategies that work well in subjects like mathematics also translate effectively to the arts, social sciences, or interdisciplinary studies. Understanding how personalization can be tailored to fit the nuances of various fields would help create more effective and context-sensitive learning experiences.

- Exploring the Role of Emotional and Psychological Factors :

While the current study primarily focused on engagement and academic performance, it is equally important to examine how personalized learning pathways (PLPs) affect students' emotional and psychological well-being. Some students may find the freedom to choose their own learning paths empowering, while others might feel overwhelmed or stressed by the lack of structure. Understanding the emotional impact of PLPs—such as stress, frustration, or satisfaction—could lead to more thoughtful design and better support systems in personalized learning environments. Future studies could

incorporate measures of student well-being, such as emotional engagement, motivation, and self-esteem, to provide a deeper understanding of how PLPs influence students psychologically. Additionally, it would be valuable to explore whether personalization helps alleviate feelings of isolation in MOOCs or if it inadvertently intensifies them, offering important insights for enhancing online learning environments.

- Investigating the Role of Technology in Adaptive Learning Systems :

This study highlighted the significance of adaptive learning systems in personalizing student experiences but also identified challenges related to system adaptability and feedback quality. Future research should focus on improving the capabilities of artificial intelligence (AI) and machine learning algorithms used in adaptive systems, ensuring they accurately personalize content and deliver meaningful, actionable feedback. Research could explore the technical development of adaptive learning systems, particularly enhancing the precision of content recommendations and feedback based on learner behavior and performance. Moreover, studies could investigate the use of natural language processing (NLP) for providing more nuanced feedback on students' written work or explore the integration of gamification techniques to further boost learner motivation and engagement. These advancements could lead to even more effective, responsive, and personalized learning environments.

XI. CONCLUSION

This study offers valuable insights into the impact of Personalized Learning Pathways (PLPs) in Massive Open Online Courses (MOOCs), particularly within the context of Moroccan business higher education. The findings highlight the significant role of personalization in enhancing student engagement, academic performance, and overall satisfaction, while also enriching the theoretical discourse on learner-centered pedagogy.

By examining PLP integration through both quantitative and qualitative lenses, the research adds a context-specific dimension to the global body of work on personalized learning. It underscores key factors such as learner autonomy, prior academic experience, and the importance of instructional scaffolding, contributing to a more nuanced understanding of how PLPs can be effectively implemented in business MOOCs.

In line with existing research, this study confirms that personalization fosters higher levels of participation, improved academic outcomes, and increased motivation among learners. However, it also draws attention to ongoing challenges, including limited adaptability of current systems, the need for more meaningful and timely feedback, and the lack of robust support for instructors. These limitations suggest that for PLPs to reach their full potential, improvements in instructional design, adaptive technologies, and social learning features are essential.

Looking ahead, future research should explore the long-term impacts of personalized learning, investigate its effectiveness across various disciplines, and consider its emotional and psychological effects on learners. Additionally,

continued innovation in adaptive learning technologies and data-driven personalization holds great promise for creating more inclusive, engaging, and effective learning experiences.

Overall, this study reinforces the transformative potential of personalized learning pathways in MOOCs. By aligning educational content with individual student needs and goals, PLPs offer a powerful strategy for enhancing engagement, supporting academic success, and shaping the future of digital education in meaningful and impactful ways.

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ChatGPT and the Future of Higher Education: Towards New Pedagogical Strategies

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Abstract

This paper explores the use of generative artificial intelligence (AI), mainly ChatGPT, for pedagogical purposes in higher education. The potential of AI to transform traditional educational and learning practices provides diverse solutions such as automated assessment, individualized learning, content generation, chatbots, language coaching, and time saving.

As an advanced AI solution, ChatGPT assists humans and improves the effectiveness of pedagogical approaches.

The study demonstrates different fields of application of AI in higher education, including accessibility, inclusivity, and improved communication and collaboration. AI promotes the enrichment of the learning experience through adapted educational tools and resources and simulations. However, the implementation of these tools requires guidance and ethical reflection on challenges such as data protection and security, clarity, and adaptation to cultural specificities.

While ChatGPT is proving to be a powerful tool, it is essential that its results be rigorously critically reviewed by human experts.

The incorporation of AI into academia has significant implications and consequences for teachers, students, and curriculum development. The application of these tools should be carefully regulated to ensure ethical and impartial application.

Keywords—Artificial intelligence, higher education, ChatGPT, teaching practices, chatbot

XII. INTRODUCTION

Generative Artificial Intelligence (AI) in education is an emerging field within educational technology (Akpan et al., 2025; Blandin & Jeunesse, 2024). Its potential benefits in higher education include personalized pedagogical support, language skills practice, simplified learning processes for students, assistance with academic activities, and customized feedback (Sain et al., 2025; Kihel, 2025; Rafiq & Quratul-Ain, 2025).

Various educational applications of AI encompass personalized learning systems, intelligent tutoring systems (Boissière & Bruillard, 2021), natural language processing (Langevin, 2022), automated assessments (Le Moli, 2022), technology-based learning platforms, and teacher-student collaboration (Piekoszewski-Cuq, 2024). As such, AI applications have the potential to transform traditional teaching and learning methods.

Recent studies on AI in higher education report a growing interest within the academic community in its educational applications (Firat, 2023; Knox, 2020). The need for deeper investigation into the role of AI in higher education—prioritizing educational and social aspects alongside technical ones—has also been emphasized (Yun et al., 2025; González-Calatayud et al., 2021). ChatGPT, an advanced AI chatbot launched in November 2022, has since experienced rapid growth and has sparked widespread interest and debate in higher education (Whalen et al., 2025; Ayyaswamy & Naren, 2025). It has emerged as a leading generative AI tool (Whalen et al., 2025) and appears to be at the forefront of a new generation of AI tools that will necessitate a rethinking of the educational process (García-López et al., 2025). ChatGPT can generate new content and human-like responses and has demonstrated remarkable competence (García-Varela et al., 2025). It is associated with various positive aspects such as personalized/adaptive learning experiences, editing, summarization, translation, research assistance, literature generation, as well as grading and assessment (Simelane & Kittur, 2025).

With regard to ChatGPT's function as a research assistant, studies have highlighted several associated benefits, including assisting with literature reviews, refining research questions, generating concise summaries, identifying relevant scholarly sources, and synthesizing research articles (Dunnigan et al., 2025; Case et al., 2025).

At the same time, challenges and concerns regarding AI and ChatGPT in higher education include cheating on assignments, over-reliance on AI tools (Kumar et al., 2025), ethical and privacy issues (Jin et al., 2025; Parsa, 2023), as well as student uncertainty and anxiety about future careers (Vishwakarma et al., 2025). Notably, concerns about the use of ChatGPT also relate to the reliability and accuracy of information, potential data biases, and academic integrity (Zahra et al., 2025; Sadallah et al., 2025).

The objective of this paper is to explore how generative AI can be leveraged to enhance pedagogical practices in higher education, using ChatGPT as a research support tool. While the application of AI in higher education is not entirely new (Xiao et al., 2025), several studies have pointed to a research gap highlighted in a recent review (Liu et al., 2025; Jan, 2025; Pavone et al., 2025), indicating that little research has focused

on how AI can assist tutors in their roles within higher education.

This study contributes to the ongoing debate on the potential of AI in higher education and the role of ChatGPT as a research assistance tool. It aims to generate international interest, as AI remains an evolving field expected to significantly influence educational practices in higher learning institutions.

XIII. RESEARCH APPROACH

A qualitative approach was used by interviewing ChatGPT. Due to the novelty of the topic, there are still relatively few studies that have applied and used ChatGPT as the subject being interviewed rather than a human participant. Kim et al. (2025) pointed out inaccurate responses provided by ChatGPT in the context of tourism-related decision-making. Another study by Walters and Wilder (2023) interviewed ChatGPT to test its creativity in managing bibliographic references and reported that the output was of similar quality to that produced by humans. GPT-4.0 is considered one of the most advanced large language models (Roumeliotis et al., 2025). Several studies have indicated that ChatGPT has been used as a research support tool to aid in the creation and generation of ideas and content (Valeri et al., 2025), in rephrasing paragraphs and finding references (Putri & Wahyudi, 2025), and in supporting qualitative (Wheeler, 2025) and technological research (Sebastian et al., 2025). Alongside the reported benefits and strengths, all studies have emphasized the need for ethical, cautious, and responsible use of such tools. For instance, Wheeler (2025) used ChatGPT as a support tool for generating and designing research ideas. He reported its usefulness in the research process while also highlighting the importance of critical thinking when evaluating the outputs produced by ChatGPT.

In order to explore the main ways in which AI can be leveraged to enhance pedagogical practices in higher education, ChatGPT was interviewed, and the following questions and prompts were submitted:

- What are the pedagogical opportunities of AI in higher education?
- How can AI support academic supervisors?
- How can AI support university students?

The responses generated and produced by ChatGPT (based on the submitted questions and prompts) were reviewed and analyzed to create main categories related to how AI can be used to enhance pedagogical practices in higher education.

Each category was further explored through Google Scholar by searching for the category's main keywords in combination with "artificial intelligence" and "higher education."

We will present the main approaches through which AI can be leveraged to enhance pedagogical practices in higher education.

XIV. ENHANCING PEDAGOGICAL PRACTICES IN HIGHER EDUCATION THROUGH GENERATIVE AI

A. Personalized Learning

AI can analyze students' learning patterns and tailor course content to their individual needs. This personalization has the potential to help students learn at their own pace, according to their interests and learning styles, to receive individualized support, and to increase their engagement (Akpan et al., 2025; Su & Yang, 2023).

In this way, students' strengths and weaknesses can be taken into account, and learning experiences can be optimized. Teachers could guide students in using AI models like ChatGPT for additional help or support. ChatGPT can provide personalized assistance to students, as it can adjust explanations and feedback according to the students' progress and preferences.

AI can also offer tailored improvement recommendations by suggesting additional resources or study materials suited to individual student needs. A recent study by Yu et al. (2025) emphasized the need for further research on various ways to support personalized learning with AI, as well as on pedagogical issues and the role of teachers. Intelligent tutoring systems are among the most effective tools for personalizing instruction. This growth in personalization is currently taking place as educational researchers experiment with new learning models (Jeannot, 2025). The potential of AI to influence how teachers provide personalized support or learning—potentially improving student outcomes—is an ongoing research issue (Yu et al., 2025). Evidence-based research is necessary, as many studies report claims regarding the potential benefits of AI.

B. Automated Assessment and Feedback Generation

AI-based systems can assist in the automated grading of assignments, quizzes, and tests, enabling educators to save time and ensure consistency in scoring. ChatGPT can automate test grading by providing quick feedback to students and allowing teachers to focus on delivering more in-depth and personalized evaluations (Ambert, 2024; Nadeau & Jobin, 2024). AI can also create adaptive assessments that adjust their difficulty based on a student's responses while providing instant feedback that highlights strengths and areas for improvement.

Analyzing student feedback to inform ongoing improvements in course content is another function of AI. Automated assessment can help students engage in self-regulated learning in both face-to-face and blended educational environments (Luo & Zhou, 2024). A recent study by Mudra (2025) suggests that higher education institutions could adopt AI tools as part of the assessment process. The implementation of AI in assessment has been linked to more robust evaluation methods and increased teacher engagement (Gong & Pang, 2025).

Evaluating the impact of AI on teaching and learning outcomes requires careful consideration of various metrics and methodologies. These may include measuring student performance through pre- and post-test score changes, course completion rates, monitoring student engagement levels, and

assessing learners' perceptions and satisfaction. It is recommended that future research further explore these areas.

C. Virtual Assistants and Chatbots

virtual assistants can help students and professors with routine administrative tasks, answer questions, and provide information about courses, schedules, and campus services. A virtual assistant can offer technical support such as helping with information retrieval or assisting in citation collection. Intelligent conversational chatbots allow students to interact online and enable tutors to create and manage their courses using generative AI tools (Akpan et al., 2025). Chatbots can answer students' questions, provide information about courses and programs, and assist students with institutional services and resources, thereby facilitating student support and engagement (Jin et al., 2025). AI-powered chatbots can assist both students and professors with inquiries, information, and administrative tasks. Being available 24/7, they can help students by answering their questions, providing information about course schedules and assignments, and even offering guidance on administrative matters.

D. Content Creation, Resource and Time Management

AI helps teachers create educational content that ultimately enhances student engagement. This includes generating exam questions, summarizing texts, and designing quizzes.

AI chatbots can create real-time conversational content, and beyond written content, they can also help produce images and videos. Designing educational content can save time for instructors and provide additional resources for students. ChatGPT, for example, can generate practice questions and mock exams to help students prepare for assessments.

AI models capable of generating diverse content have introduced innovation across various fields such as natural language processing, creative arts, and computer vision (George & Wooden, 2023; Chan & Hu, 2023). Sophisticated AI models capable of producing coherent and grammatically correct texts are transforming the field of human-computer interaction, offering various practical applications such as email writing or personal assistant tasks (George & Wooden, 2023).

AI can recommend relevant research articles, textbooks, and online resources to students and supervisors to support their learning and teaching efforts. AI applications can analyze schedules, workloads, and learning habits of students to provide personalized recommendations for effective study planning and time management. This can help students balance their academic responsibilities and avoid burnout.

Researchers have reported the use of AI in identifying learning patterns, sequencing curricula, instructional design, student management, and the provision of information and organization.

E. Translation and Language Support

Students can practice their language skills through AI-powered chatbots that answer their questions (Anger, 2024). Language learning applications and translation tools

supported by AI can help students and teachers overcome language barriers.

By providing real-time translation into other languages, education can become more accessible to a wider range of students, especially international ones (Sofa, 2024). Chatbots can serve as useful supplementary resources to overcome language and cultural barriers, although they cannot replace the expertise and guidance of human tutors (Sofa, 2024).

In this way, language skills can be practiced and improved, leading to more engaging learning experiences. Students and teachers can also be supported in language-related tasks such as proofreading and linguistic translation, which is particularly useful in multilingual educational settings.

F. Research Support

AI-based tools can assist both teachers and students with literature review, data analysis, reading synthesis, and the identification of relevant research trends and patterns.

The benefits of using AI tools in research include text generation, allowing researchers to save time and effort so they can focus on other aspects of their projects; assistance in literature review by processing large volumes of data quickly; support in data analysis and interpretation; and help with peer-review activities (Mohammed et al., 2025). With the massive amount of data and knowledge available, AI technologies are capable of efficiently processing large datasets, helping researchers stay up to date with the latest research trends.

ChatGPT can support and enrich the research activities of students and scholars (Bohni Nielsen et al., 2025) by synthesizing academic texts and research articles, improving language use, generating diagrams and ideas, suggesting keywords, refining research questions, and identifying relevant academic sources. Chen et al. (2025) explored the role of ChatGPT as a writing assistant and suggested that future research should examine students' ability to use it as a tool for writing and research support.

G. Simulations and Virtual Labs

Artificial intelligence can support the creation of interactive simulations and virtual reality experiences that enhance learning by making it more immersive and student-centered. These tools can be tailored to match individual learning styles, supported by adaptive feedback to improve outcomes.

Universities increasingly adopt VR and simulation technologies to create active, hands-on learning environments. These approaches immerse students in realistic scenarios, promoting deeper engagement and understanding (Ren & Wu, 2025). This is particularly valuable in disciplines where physical experiments are costly, hazardous, or difficult to replicate.

AI-driven virtual labs provide practical training in fields such as science and engineering without requiring physical resources. For example, ChatGPT can simulate lab experiments, enabling learners to interact with scientific processes in a safe and flexible digital environment.

H. Collaboration and Communication

AI tools facilitate collaboration between students and faculty through integrated features such as chat, video conferencing, and collaborative document editing, thereby streamlining group assignments and project-based learning. These technologies also enable researchers to work jointly toward shared academic goals, enhancing both productivity and knowledge exchange (Ivaniceva & Daou, 2025).

Students increasingly use AI systems like ChatGPT to support collaborative tasks, including brainstorming, peer discussions, and co-authoring academic work. Ivaniceva and Daou (2025) emphasize the role of AI in fostering collaborative learning, highlighting its benefits in both face-to-face and digital settings. Their findings underline how AI contributes to the development of communication, cooperation, and higher-order thinking skills.

Moreover, AI facilitates access to real-time communication training resources, supporting students' interpersonal skill development (Wang, 2025). Recent research also points to AI's role in socially shared regulation of learning, where human and machine capabilities are integrated through hybrid intelligence models (Nikitenko et al., 2025).

These AI-driven interactions are especially relevant in online education, a modality that has expanded considerably in higher education since the COVID-19 pandemic (Acharya, 2025), reinforcing the need for intelligent and adaptive collaborative tools.

I. Accessibility and Inclusiveness

AI holds considerable potential to promote inclusion and equity in education, provided its design and implementation are ethical and context-sensitive. Through personalized learning pathways, AI can support differentiated instruction tailored to individual students' abilities, preferences, and learning styles, fostering more inclusive educational experiences.

AI-powered platforms offering online courses extend access to learners who may face geographic, economic, or institutional barriers to traditional higher education. Additionally, integrated language translation tools allow content to be delivered in students' native languages, enhancing accessibility for multilingual learners. AI technologies have also demonstrated positive impacts on the quality of life for individuals with disabilities, notably by improving access to educational content and communication tools (Bui & Tong, 2025).

ChatGPT and similar models can support diverse learners by offering alternative content formats—such as text-to-speech or simplified explanations—particularly benefiting students with learning disorders, visual impairments, or limited proficiency in the language of instruction (Papalexandratou et al., 2024). Such capabilities contribute to the creation of adaptive and student-centered learning environments.

However, while AI can foster inclusive education, it also raises important ethical concerns. As highlighted by Chalkiadakis et al. (2024), biases in training data and unequal access to AI tools may inadvertently reinforce existing disparities. These risks necessitate careful design choices, continuous evaluation, and equitable implementation

strategies to ensure AI technologies serve all learners effectively, without exacerbating educational inequalities.

XV. DISCUSSION

This article has explored various ways in which AI can be leveraged to enhance pedagogical practices in higher education. In this study, ChatGPT was employed as a research assistance tool. The responses generated by ChatGPT, based on the posed inquiries, provided an initial framework for deeper investigation, thereby facilitating the research process. While the content produced by ChatGPT was generally reliable, some redundancy was observed across outputs. These results were critically evaluated, triangulated with recent scholarly literature, and subsequently refined.

Consistent with current research, this study confirms that AI can significantly improve teaching and learning in higher education through multiple applications, including personalized learning, automated assessment and feedback, virtual assistants and chatbots, content generation, translation and language support, research facilitation, simulations, and virtual laboratories. These innovations collectively contribute to enhancing collaboration, communication, resource sharing, time management, and accessibility for both educators and learners.

It is important to acknowledge the interconnectedness of these AI applications. For example, resource recommendation functionalities are closely tied to AI's role as an educational assistant supporting both instructors and students. AI tools possess considerable potential to empower educators, enabling informed decision-making based on data-driven insights about student learning and engagement.

Nevertheless, despite the promising benefits reported in the literature, there remains a critical need for rigorous, evidence-based studies that systematically measure the actual impact of AI tools on pedagogical effectiveness and learning outcomes. In the present study, the use of ChatGPT as a research assistant facilitated the investigation, yet the outputs required thorough validation and human oversight.

Ultimately, AI tools like ChatGPT should be viewed as complementary instruments that augment, rather than replace, human educators. Their outputs demand careful evaluation and contextual interpretation by researchers and practitioners to mitigate risks associated with inaccurate or misleading information. Therefore, researchers, educators, and students should avoid exclusive reliance on AI-generated content, especially in specialized fields where expert judgment is essential.

Future research should focus on developing robust frameworks for integrating AI into higher education pedagogy, ensuring ethical considerations, inclusivity, and efficacy remain at the forefront of technological adoption.

A. Ethical Considerations

The implementation of generative AI tools such as ChatGPT in higher education requires careful consideration of ethical concerns, potential risks, and the possibility of misuse. Key ethical issues include data privacy, inherent biases in AI algorithms, lack of transparency, accessibility challenges,

cultural sensitivity, and potential negative impacts on students' critical thinking and creativity.

These limitations often stem from biased or misleading outputs influenced by the training data, inaccuracies in generated content, and opaque processes related to data selection and algorithmic decision-making. For example, Li (2024) noted that ChatGPT aligns well with Canadian cultural norms but shows reduced adaptability to diverse cultural contexts, which may affect its global applicability.

In the present study, ChatGPT's use as a research support tool highlighted specific constraints, such as lacking internet access and updates on the latest scientific developments. This limitation restricts the tool's ability to provide comprehensive and current scholarly information—an essential requirement in academic research. Hence, ChatGPT should be seen as a complementary tool, augmenting rather than replacing human expertise.

Educational risks associated with ChatGPT include generating inaccurate, implausible, or inappropriate content; users' preference for AI-generated text over human work; inadvertent disclosure of sensitive personal data; and exacerbating the digital divide due to unequal access and varying digital literacy levels. Academic integrity concerns, including cheating and plagiarism, have been widely reported (Kuzminska et al., 2023). The ease of obtaining AI-generated content is perceived as a threat (Aad & Hardey, 2025), fueling ongoing debates about potential misuse in education (Vartiainen et al., 2025).

A systematic review of large language models in education (García-López et al., 2025) identified challenges such as limited technological readiness, insufficient transparency, and weak data privacy protections. Addressing these ethical and pedagogical issues, particularly in the context of expanded blended and online learning post-pandemic, remains a critical research priority (Daniel et al., 2025). Meanwhile, Songsingchai (2025) emphasizes AI's promising role in supporting academic writing within blended learning frameworks, highlighting the nuanced balance between innovation and caution.

B. Implications: Technological Literacy and Training

The integration of ChatGPT and other generative AI tools into higher education has profound implications for educators, students, curriculum design, and institutional policies. Effective implementation requires comprehensive training and ongoing support to ensure that both students and educators can navigate these technologies confidently and ethically. Recent research highlights the necessity of incorporating generative AI comprehension as a core component of digital literacy curricula (Akpan et al., 2025). Proper training enables users to overcome technical barriers, understand AI functionalities, critically interpret generated outputs, and harness AI benefits responsibly.

Training initiatives, including workshops and professional development programs, should target AI literacy enhancement for all stakeholders. Key competencies include critical thinking, problem-solving, and effective communication. Educators require pedagogical and technical training to fully exploit AI tools like ChatGPT and to act as facilitators who guide students in ethical AI use while

addressing concerns such as data privacy, plagiarism, and algorithmic transparency (Kabir et al., 2025).

Encouraging students to critically analyze AI-generated content can foster deeper understanding of these tools' capabilities and limitations. While AI can increase efficiency, it cannot substitute for human expertise, especially in tasks demanding ethical judgment, such as academic writing. Training students in ChatGPT literacy supports the development of writing skills and academic rigor. As Labib and ElSabry (2025) argue, ChatGPT presents both opportunities and challenges that require cautious integration into higher education.

Given recent advances in AI-generated multimedia content—including realistic images, videos, and voice cloning—it is essential to raise students' awareness about these emerging technologies. Training programs should be designed to cultivate higher-order cognitive skills like creativity, critical thinking, and problem-solving while avoiding overreliance on AI tools. Curriculum redesigns may be necessary to incorporate ethical considerations and address bias in AI applications.

Universities are encouraged to establish clear policies and ethical guidelines to ensure responsible AI use aligned with pedagogical goals. Collaboration among administrators, policymakers, and educators is vital for developing frameworks that maximize AI's benefits while mitigating risks. Additionally, assessment methods should evolve to prioritize evaluation of complex cognitive skills over rote technical knowledge, helping to prevent plagiarism and misuse.

Continuous training is critical, given the rapid pace of technological change. Staff and students should be regularly updated on ethical challenges, data privacy, and the potential inaccuracies of AI-generated information. Furthermore, partnerships between higher education institutions and AI developers can facilitate the creation of tools that align with educational values and needs.

Pedagogically, this integration calls for flexible curricula, ongoing professional development, inclusion of AI ethics courses, and support for self-directed student learning (Ige et al., 2025). Future research should investigate sustainable models for embedding AI tools in education, with Jin et al. (2025) advocating for comprehensive training that equips both educators and students with generative AI competencies, reshaping the future landscape of higher education.

C. Limitations and Future Research

This study has several limitations. Firstly, the initial queries submitted to ChatGPT did not specify the context of AI usage—whether in face-to-face, online, or blended learning environments, nor did they target specific academic disciplines. Given the accelerated digitalization of higher education during the pandemic and the increasing prevalence of blended and online learning, it is essential to investigate AI's opportunities and challenges across diverse instructional modes. Kerimbayev et al. (2025) notably explored AI applications in online learning environments.

Furthermore, future research should examine AI's capabilities and constraints within specific academic domains. For example, Bewersdorff et al. (2025) analyzed AI's potential in language education, while fields such as engineering, computer science, and language instruction have been identified as prominent areas for AI integration in higher education (Kihel, 2025; Anger, 2024; Luo & Zhou, 2024).

Another limitation lies in ChatGPT's temporal knowledge cutoff and lack of access to real-time data, restricting its ability to provide the most current information. Additionally, this study's outputs were reviewed solely by the author, whose prior knowledge influenced result interpretation; consequently, some recent relevant studies may have been overlooked. Involving domain experts in future research would strengthen the validity and depth of findings.

Moreover, this study did not investigate specific case studies or concrete examples of ChatGPT's use within higher education. Future work should include empirical investigations to assess practical implementations and outcomes.

Lastly, research is needed to explore the long-term impacts of AI integration on higher education pedagogy and practice. While many existing studies speculate on AI's potential, there is a pressing need for rigorous, evidence-based research. As generative AI continues to evolve rapidly, its role as a core digital literacy component and its integration with existing educational technologies warrant focused examination as an emerging and critical research domain.

XVI. CONCLUSION

This study has demonstrated that artificial intelligence (AI) can be leveraged in multiple ways to enhance pedagogical practices in higher education, with ChatGPT standing out as a significant AI tool capable of generating content and stimulating ideas for further academic inquiry. Serving as a valuable research assistant, ChatGPT supports both educators and students throughout the research process. Nonetheless, human supervision, expertise, and active engagement remain indispensable to ensure accuracy and contextual relevance.

This work contributes meaningfully to the ongoing discourse on ChatGPT's role as a research assistant in higher education. While it offers substantial support to researchers, students, and instructors, ChatGPT should function as a complementary tool that enriches rather than replaces traditional pedagogical methods and the irreplaceable role of human educators. Understanding and addressing its limitations is vital to fostering a balanced and effective user experience. Moreover, potential risks—such as the generation of implausible or inaccurate outputs, embedded biases, ethical dilemmas, threats to academic integrity, and exacerbation of the digital divide—must be carefully managed.

The deployment of generative AI tools like ChatGPT in higher education implicates educators, learners, curriculum developers, and institutional policymakers. Ensuring adequate training and support is essential for thoughtful and effective AI integration within academic environments.

As AI technologies evolve rapidly, responsible implementation necessitates a comprehensive understanding of their benefits alongside inherent risks and potential misuses. The impact of AI on higher education remains emergent, presenting transformative possibilities for teaching and learning. However, integration must proceed collaboratively with human educators, whose unique qualities—such as empathy, nuanced understanding of students' needs, and mentorship—are central to the educational experience.

This collaborative synergy between AI and human educators will maximize AI's advantages while addressing ethical challenges. The development of innovative ethical and pedagogical frameworks is becoming increasingly critical. Striking and maintaining a balance between technological tools and human intervention is fundamental to cultivating engaging, inclusive, and effective learning environments.

Identifying optimal strategies to harness AI for supporting and enhancing educational practices in higher education remains a fertile and evolving area of research. Ongoing investigations continue to examine the pedagogical implications of AI, the evolving roles of educators, and the dynamic integration of AI in formal academic settings, promising to shape the future landscape of higher education.

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The Use of Artificial Intelligence Tools and Psychological Well-Being Among Moroccan University Professors: A Qualitative Study

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Abstract— This qualitative study explores how artificial intelligence (AI) tools influence the psychological well-being of university professors in Morocco. Despite the rapid integration of AI in higher education, limited research addresses its psychological impact on educators, particularly in developing countries facing unique infrastructural and cultural challenges. Through semi-structured interviews with 17 professors across Moroccan universities, this study examined effects on stress levels, job satisfaction, and mental health using thematic analysis. Findings reveal a complex relationship where AI simultaneously reduces administrative burden while introducing new stressors related to technological adaptation and changing professional roles. The study identified four distinct psychological profiles among professors using AI: "Optimizers," "Balancers," "Vigilants," and "Ambivalents." The Job Demands-Resources Model and Digital Stress Theory illuminate these dynamics, particularly how AI functions both as a resource (reducing workload) and a potential demand (requiring adaptation). Recommendations include phased implementation strategies, comprehensive training programs, and developing culturally-appropriate ethical frameworks. This research contributes to understanding technology-human integration in educational settings while highlighting the importance of contextual factors in developing regions.

Keywords— Artificial intelligence, psychological well-being, university professors, Morocco, mental health, stress.

XVII. INTRODUCTION

The integration of Artificial Intelligence (AI) tools in higher education represents one of the most significant technological shifts in academic settings in recent years. This transformation has been particularly pronounced in Morocco, where educational institutions are increasingly adopting AI technologies to modernize teaching practices and enhance learning experiences [1]. As AI tools such as ChatGPT and other generative AI applications become more prevalent in university settings, understanding their impact on the psychological well-being of educators becomes critically important.

The integration of AI in Moroccan higher education must be understood within the global context of technology adoption in developing countries. While AI adoption is rising globally, low-resource institutions in countries like Morocco face significant infrastructure gaps [2]. Only approximately 30% of Moroccan universities have dedicated AI training programs [2], creating challenges for widespread integration.

Additionally, cultural factors influence adoption, as faculty in developing nations often view AI as a "Western imposition" unless aligned with local pedagogical approaches and values [3].

Despite the growing body of research on AI in education, limited attention has been paid to the psychological impact of these technologies on educators, particularly in developing countries with unique contextual challenges. Most existing studies focus on technological implementation or student outcomes, neglecting the lived experiences of university professors navigating these changes [4]. This gap is particularly pronounced in the Moroccan context, where the intersection of technological advancement, cultural factors, and institutional constraints creates a unique environment for AI integration.

A. Research Objectives and Questions

This study aims to examine how AI tools influence the psychological well-being of university professors in Morocco by addressing the following research questions:

- How do AI tools affect the stress levels and workload management of university professors in Morocco?
- What is the relationship between AI integration and job satisfaction among Moroccan university professors?
- How do professors experience and navigate the mental health implications of AI adoption in their teaching practices?

XVIII. LITERATURE REVIEW

A. Job Demands-Resources (JD-R) Model

The Job Demands-Resources (JD-R) model provides a theoretical foundation for understanding how AI tools influence faculty psychological well-being [5]. This model conceptualizes job characteristics as either demands (aspects that require sustained effort and may lead to strain) or resources (aspects that help achieve goals, reduce demands, or stimulate growth).

AI tools can function as job resources by automating administrative tasks and enhancing teaching capabilities. However, they may simultaneously create new job demands through implementation challenges, required technical learning, and role adaptations. According to the JD-R model, psychological well-being results from the balance between these demands and resources. When AI-related demands exceed available resources, stress and burnout may occur; conversely, when AI enhances resources without creating overwhelming demands, improved engagement and satisfaction may result.

B. Digital Stress Theory and Technostress Creators Model

Digital Stress Theory [6] explains how technology integration creates unique psychological stressors, including:

- Techno-overload: Information and multitasking demands exceeding cognitive capacity
- Techno-invasion: Blurring of personal and professional boundaries
- Techno-complexity: Feelings of inadequacy due to technological learning requirements
- Techno-insecurity: Fears about job displacement or devaluation
- Techno-uncertainty: Constant changes in technological tools and requirements

These dimensions are further elaborated in the Technostress Creators Model [7], which examines how these stressors lead to specific psychological outcomes including job dissatisfaction, reduced organizational commitment, and decreased productivity. The model also identifies "technostress inhibitors" such as technical support, literacy facilitation, and involvement in implementation that can mitigate negative psychological impacts. This framework is particularly relevant for understanding the complex psychological responses of university professors to AI integration.

C. Technology Acceptance Model (TAM) and UTAUT2

The Technology Acceptance Model (TAM) and its extension, the Unified Theory of Acceptance and Use of Technology (UTAUT2), provide complementary frameworks for understanding faculty adoption of AI tools [8]. These models identify key factors influencing technology adoption:

- Performance expectancy: Belief that technology will enhance job performance
- Effort expectancy: Perceived ease of use
- Social influence: How colleagues and institutional culture shape adoption

- Facilitating conditions: Infrastructure and support available
- Hedonic motivation: Enjoyment derived from technology use
- Price value: Perceived benefits relative to costs
- Habit: Automatic behavioral patterns with technology

These factors help explain the varied psychological responses to AI among faculty members, as individual differences in these dimensions influence whether technology integration is experienced as psychologically beneficial or detrimental. For example, professors with high performance expectancy but low facilitating conditions may experience heightened frustration and stress during implementation.

D. Prior research on IA in higher education

Research on AI integration in higher education has primarily focused on implementation strategies, pedagogical applications, and student outcomes (Zhang, 2024). Studies have documented the increasing use of AI tools for content creation, assessment, administrative tasks, and personalized learning [9]. However, fewer studies have examined faculty experiences with these technologies, particularly regarding psychological impacts.

In the global context, research indicates that faculty responses to AI integration vary significantly based on institutional support, technological infrastructure, and cultural factors [1]. Faculty in well-resourced institutions with robust technological infrastructure typically report more positive experiences compared to those in resource-constrained environments [3].

E. Psychological impacts of educational technology

Studies examining the psychological impacts of educational technology adoption have identified several key themes. Torres et al. [4] conducted a systematic review finding that technology integration initially increases stress during adoption phases before potentially reducing workload in the longer term—a pattern described as the "J-curve effect" [10]. Their analysis of faculty experiences found that 68% reported higher stress levels during the first six months of new technology implementation.

Burnout among faculty has been extensively studied by Maslach and Leiter [11], who emphasize that technological solutions address only part of the burnout equation. Their work highlights that while AI may reduce workload, it does not necessarily address other burnout factors such as lack of autonomy, insufficient recognition, or value conflicts.

Digital fatigue represents another documented psychological impact, with the JISC [12] report finding that 42% of faculty report exhaustion from managing multiple digital tools. This fatigue appears particularly pronounced when multiple technologies are implemented simultaneously without adequate integration or training.

XIX. METHODOLOGY

A. Methodology and Participant Overview

This research employed a qualitative approach involving semi-structured interviews conducted in French with 17 university professors from diverse public and private

institutions across Morocco, representing multiple academic disciplines including humanities, social sciences, natural sciences, engineering, business, and law. Participants were recruited through purposeful convenience sampling based on three key criteria: current employment as a professor at a Moroccan university, experience using at least one AI tool in teaching or research activities, and willingness to reflect on the psychological impacts of AI integration.

The interview protocol comprehensively explored participants' initial experiences with AI integration, specific tools and technologies utilized, motivations for adoption, perceived benefits in efficiency and innovation, changes in pedagogical methods and student interactions, impacts on research processes, encountered challenges, effects on psychological well-being and work-life balance, and perspectives on the future evolution of AI in Moroccan higher education, thereby providing rich qualitative data on the multifaceted experiences of educators navigating technological transformation in their professional practices.

B. Data Analysis

The interview transcripts underwent systematic thematic analysis following a structured six-phase process that began with familiarization through repeated reading of transcripts to develop comprehensive understanding of the data content. Initial coding was then conducted to identify key concepts and emerging patterns within participants' responses, followed by the development of preliminary themes through strategic grouping of related codes that shared conceptual similarities. The analysis process continued with careful review and refinement of these themes to ensure they accurately represented the data and captured meaningful insights about professors' experiences with AI integration. Subsequently, themes were clearly defined and appropriately named to reflect their essential characteristics and scope, culminating in the production of a final comprehensive analysis that incorporated illustrative quotes from participants to substantiate findings and provide authentic voices to support the interpretive framework developed through this rigorous analytical approach.

XX. RESULTS

A. AI Adoption and Usage Patterns

1) Initial AI Integration

Professors described varied pathways to initial AI adoption, with many beginning their exploration through generative AI tools like ChatGPT, driven by curiosity or specific academic needs. As one participant explained, *"I started integrating Artificial Intelligence progressively, first through text generation tools like ChatGPT to assist with scientific writing, then in my courses, using data visualization and analysis tools,"* while another noted beginning *"out of curiosity, testing tools to help me prepare my courses and save time in writing."* Several participants

emphasized a cautious, incremental approach to integration, with one stating, *"I started integrating Artificial Intelligence into my academic activities with caution,"* and another describing, *"I began using artificial intelligence progressively. My first encounter with Artificial Intelligence dates back to the end of 2022, when I discovered the ChatGPT tool."* This gradual adoption reflected both genuine interest in AI's potential and legitimate reservations about its limitations, with several professors noting initial skepticism that evolved into more regular use as the technology improved. One participant captured this evolution particularly well, explaining, *"At first, I was impressed by its capabilities, but when asking certain questions, I quickly noticed that the responses provided were sometimes erroneous or imprecise. Faced with these limitations, I decided to stop using it. However, a few months later, Artificial Intelligence made significant progress in terms of performance, offering more structured and reliable responses."*

2) Types of AI Tools Used

The most commonly used AI tools among participants were generative AI platforms, particularly ChatGPT, which was mentioned by nearly all respondents. Other tools included:

AI Tools Used by Moroccan University Professors

Tool Category	Specific Tools Mentioned	Primary Academic Applications
Generative AI	ChatGPT, Claude, Perplexity, DeepSeek, Gemini, Copilot, GROK	Content creation, teaching materials, research writing
Translation/ Language	DeepL	Document translation, language improvement
Document Analysis	ChatPDF	Literature reviews, article analysis
Voice Assistants	Google Assistant	General information queries
Image Generation	DALL·E, MidJourney	Teaching materials, visual content
Research Tools	Elicit, Petal	Scientific research, literature analysis

Table .1

3) Motivations for AI Adoption

The primary motivations for adopting AI centered around efficiency, time savings, and quality improvements in academic work. As one professor articulated, *"Time savings in writing and data analysis. The pursuit of quality and innovation in academic*

productions. *The necessity to stay current with digital tools used by my students and colleagues.*" Another participant emphasized practical benefits, stating they adopted AI *"to simplify my work. Save time in preparation and organization. Bring a more modern and dynamic aspect to my courses."* These motivations align well with the Job Demands-Resources model, with professors seeking to enhance their job resources through technology while managing existing demands. The responses reveal a strategic approach to AI integration, where educators view these tools not merely as technological novelties but as practical solutions to address persistent challenges in academic work, including time constraints, quality enhancement needs, and the imperative to remain technologically relevant in an evolving educational landscape where both students and colleagues increasingly utilize digital tools.

B. Impact on Workload and Efficiency

1) Administrative and Task Efficiency

Professors consistently reported significant time savings and improved efficiency in administrative and routine academic tasks:

"AI allows me to save precious time."

"It provides enormous time savings."

"AI has accelerated my work by quickly providing summaries."

These efficiency gains were particularly noted for specific tasks:

"Time savings in data and information research."

"Artificial intelligence has brought me several concrete advantages in my professional activities. In terms of efficiency, it has allowed me to considerably reduce the time devoted to certain repetitive or time-consuming tasks, such as writing emails."

2) Quality Enhancement

Beyond time savings, professors reported improvements in the quality of their academic work:

"Improvement in the quality of analyses thanks to high-performing tools."

"Writing assistance to improve the structure and clarity of texts."

"In terms of quality, it contributes to improving the clarity, coherence and style of my written productions, particularly in English, which is particularly useful in the context of evaluation reports or scientific communications."

3) Task Redistribution Rather Than Simple Reduction

Several professors noted that AI didn't necessarily reduce overall workload but rather redistributed their time toward higher-value activities:

"I can focus on high value-added content."

"Allows me to refocus on things with higher added value."

"It has allowed me to concentrate more on substance and critical analysis."

This shift toward more meaningful academic work represents a key benefit for psychological well-being, allowing professors to

focus on aspects of their role they find more intrinsically rewarding.

C. Impact on Teaching Practices and Student Interactions

1) Enhanced Teaching Materials and Methods

Professors reported significant changes in how they prepare and deliver educational content:

"I have introduced pedagogical activities integrating Artificial Intelligence, notably case studies based on real data."

"My courses are more interactive, and I use practical examples generated by Artificial Intelligence."

"Artificial Intelligence has enriched my teaching methods by allowing me to create more interactive and personalized materials."

Many highlighted the ability to create more practical, example-rich materials:

"Artificial Intelligence has allowed me to propose concrete examples after each theoretical aspect, which enables students to link key concepts to field reality."

2) Student Engagement and Performance

Professors generally observed positive changes in student engagement, though with some important caveats:

"Yes, I have noticed an increase in engagement and participation, notably thanks to the use of concrete examples generated by Artificial Intelligence and visualizations that make concepts more accessible."

"Yes, they participate more, are more curious and seek to use these tools themselves in their projects."

"Students show themselves to be more curious and autonomous, particularly when they use Artificial Intelligence to deepen a subject or prepare presentations."

However, some professors noted concerns about over-reliance and reduced student effort:

"Yes, changes I can say negative, the student no longer wants to make an effort. He is satisfied with the return from chatgpt for example, without real added value."

"Quite the contrary, I have noticed that students use Artificial Intelligence more for all questions. This is a limitation for me because students no longer seek to read books and works to find information."

D. Impact on Research Processess

1) Literature Review and Analysis

AI tools have significantly transformed how professors approach literature reviews and document analysis:

"Artificial Intelligence has considerably accelerated data analysis. It has also helped me structure my scientific articles, improve text clarity, and save time in the proofreading phase."

"I can interrogate a PDF document by going directly to the essential."

"Artificial Intelligence has allowed me to save precious time in bibliographic synthesis, by quickly extracting key information from scientific articles."

2) Writing and Publication

Several professors noted AI's impact on their academic writing process:

"The acceleration of documentary research and the improvement of article writing."

"The automation of certain complex statistical analyses. Writing assistance to improve the structure and clarity of texts."

"Thanks to these tools, the writing process has become more fluid and less laborious."

This assistance was particularly valued for non-native language writing:

"Given that my research is mostly written in English, I previously encountered certain difficulties related to formulation, style fluidity and linguistic precision. AI has been of great help to me on these aspects."

3) Data Analysis

Some professors reported using AI for data analysis, particularly for qualitative research:

"And then for interview analysis in the context of qualitative research, which allows me to do coding easily and identify the most important passages, and also to compare several interviews."

"The automation of certain complex statistical analyses."

However, others explicitly noted not using AI for data analysis:

"On the other hand, I have not yet resorted to artificial intelligence for data analysis. This aspect of my work remains for the moment treated in a classic manner, without integration of Artificial Intelligence tools."

E. Psychological Impact of IA Integration

1) Stress Reduction and Relief

Many professors reported significant stress reduction as a direct psychological benefit of AI use:

"This brings a feeling of relief and efficiency."

"Through the reduction of research stress by decreasing the workload and ensuring good time management."

"Artificial Intelligence brings a certain relief by facilitating organization and accelerating certain tasks, which reduces stress related to deadlines."

"Reduction of stress related to repetitive and time-consuming tasks."

The relationship between time efficiency and stress reduction was consistent across interviews:

"This time saving translates into better organization of my work, a reduction in mental load."

"AI has improved our work-life balance."

2) Enhanced Professional Confidence and Satisfaction

Several professors reported increased confidence and professional satisfaction:

"Learning new solid code strengthens our skills and reinforces our self-confidence."

"The time savings allow me to perform several tasks per day, with sharp and diversified content, this allows me to be more confident before each intervention. This seems to me to be a form of well-being."

This enhanced confidence appears to stem from both improved output quality and increased productivity:

"By saving me precious time [...] it has allowed me to refocus on things with higher added value. Result: less mental overload, less time spent outside usual hours to 'wrap up' what's dragging."

3) Technology-Related Stress and Pressure

Despite the benefits, professors also reported new forms of stress related to technology adaptation:

"But sometimes additional pressure to 'stay up to date' in the face of the speed of technological developments."

"But it can also be stressful with the fear of not mastering everything."

"Continuous adaptation to new technologies can sometimes create additional pressure."

These concerns align with the "techno-complexity" and "techno-uncertainty" dimensions of Digital Stress Theory, highlighting the psychological challenges of keeping pace with rapidly evolving technologies.

F. Work-Life Balance Effects

Most professors reported positive effects on work-life balance, with participants noting that *"Overall, Artificial Intelligence has improved my balance by helping me manage my time more efficiently,"* and *"Artificial Intelligence has slightly improved my balance by lightening the workload on certain routine tasks, which allows me to free up more time for personal activities."*

Professors provided specific examples of these improvements, explaining how *"Thanks to Artificial Intelligence, I was able to finish a report more quickly and spend more time with my family,"* and *"If I do work in 2 hours instead of 4 hours, it allows me to spend more time with family or friends,"* with another noting that *"Artificial Intelligence has allowed me to finish certain research projects more quickly, which has given me more time for my family activities."*

However, despite these positive effects, some professors emphasized the need for conscious boundary setting, highlighting concerns about *"permanent vigilance not to be constantly solicited by automated tasks"* and noting that *"I sometimes feel the need to disconnect from the constant solicitation of digital tools."*

The time efficiency offered by AI tools appears to create space for personal activities, potentially reducing work-related stress and enhancing overall well-being, though

positive work-life balance outcomes depend not just on the tools themselves but on how professors manage their relationship with the technology.

G. Challenges and Concerns

1) Ethical and Authenticity Concerns

Ethical considerations emerged as a significant theme, with professors expressing concerns about *"The major challenge relates to the ethics and authenticity of the information produced"* and *"The ethical limits concerning content creation,"* emphasizing that *"It is essential not to place blind trust in the results provided by these tools"* and noting *"I remain reluctant about the idea of generating content and appropriating it, without regular control or adaptation to context."* These ethical concerns add a layer of cognitive load as professors feel responsible for verifying AI outputs, highlighting *"The difficulty of systematically verifying the reliability of generated responses"* and *"The necessity of controlling the content each time and contextualizing it."*

2) Technical and Training Challenges

Technical challenges and training needs were frequently mentioned, including *"Understanding certain technical functionalities,"* with participants noting that *"These challenges are mainly related to training"* and *"The cost of software and sometimes the lack of training complicates access to very sophisticated software,"* requiring *"The necessity of continuous training to follow the rapid evolution of these tools."* These technical barriers represent significant obstacles to optimal AI integration in academic settings.

3) Concerns About Student Learning Impact

Several professors expressed concerns about how AI affects student learning, observing that *"I have noticed that students use Artificial Intelligence more for all questions. This is a limitation for me because students no longer seek to read books and works to find information"* and *"The student no longer wants to make an effort. He is satisfied with the return from chatgpt for example, without real added value."* One professor described a specific problematic example: *"For example, during an exercise where I asked them to conduct research on several Moroccan companies to identify their main activities, some students resorted directly to Artificial Intelligence instead of consulting official websites or activity reports of these companies. The result: some of the information provided was totally erroneous."* These concerns reflect broader questions about how AI is reshaping the educational landscape and professors' roles within it.

H. Typology of Psychological Experiences

The thematic analysis of interview data revealed four distinct psychological profiles among professors using AI tools, which we have categorized as:

1) The "Optimizers"

These professors primarily focus on efficiency gains and productivity enhancement. Their psychological well-being derives from:

- Time savings and workload reduction
- Automation of repetitive tasks
- Quality improvements in output

Representative quote:

"Elle m'a permis de gagner un temps précieux dans la formulation des idées, la structuration des paragraphes."

Optimizers view AI primarily as a resource in the Job Demands-Resources framework, with limited acknowledgment of potential demands.

2) The "Balancers"

These professors emphasize improved work-life balance and prioritization. Their psychological well-being stems from:

Better boundaries between professional and personal life
More time for personal activities and relationships

- Reduced after-hours work

Representative quote:

"L'IA a amélioré mon équilibre en m'aidant à gérer mon temps plus efficacement."

Balancers see AI as facilitating a healthier relationship with work, reducing stress and enhancing quality of life.

3) The "Vigilants"

These professors maintain a cautious approach, focusing on ethical concerns and potential pitfalls. Their psychological experience includes:

- Ongoing verification of AI outputs
- Ethical considerations about authenticity

Cautious approach to dependency

Representative quote:

"Il est essentiel de ne pas accorder une confiance aveugle aux résultats fournis par ces outils."

Vigilants experience more cognitive load related to monitoring AI use but prioritize ethical integrity over maximum efficiency.

4) The "Ambivalents"

These professors report mixed experiences, acknowledging both benefits and challenges. Their psychological experience includes:

Appreciation of efficiency gains alongside dependency concerns
Recognition of stress reduction alongside adaptation pressure
Balanced view of technological change

Representative quote:

"It has improved our balance [...] but constant adaptation to new technologies can sometimes interfere."

Ambivalents experience AI's impact on well-being as complex and multifaceted, requiring ongoing negotiation.

Psychological Experience Profiles of Professors Using AI

Profile	Primary Focus	Psychological Benefits	Psychological Challenges	View of AI in JD-R Model
Optimizers	Efficiency & Productivity	Time savings, Reduced workload	Minimal reported challenges	Primarily as a Resource
Balancers	Work-Life Equilibrium	Better boundaries, Personal time	Setting limits on technology use	Resource for life quality
Vigilants	Ethics & Authenticity	Professional integrity	Verification burden, Ethical concerns	Both Resource and Demand
Ambivalents	Balance Perspective	Mixed benefits	Adaptation demands, Dependency concerns	Complex interaction of Resources and Demands

Table. 2

XXI.DISCUSSION

A. AI's Dual Role in Psychological Well-being

The findings reveal that AI tools play a dual role in professors' psychological well-being, functioning both as a resource and as a potential demand within the Job Demands-Resources framework. As a resource, AI reduces workload through automation, enhances productivity, and improves output quality. This aligns with professors' statements about reduced stress, increased confidence, and improved work-life balance.

However, AI simultaneously creates new demands through required learning, adaptation pressures, ethical considerations, and dependency concerns. This duality explains the mixed psychological experiences reported by many participants, particularly those in the "Ambivalents" category who explicitly acknowledge both positive and negative impacts.

The most psychologically beneficial implementation appears to be one where AI enhances resources without creating overwhelming new demands. This optimal balance appears more likely when:

1. Professors receive adequate training and support for technical aspects

2. Institutional ethical frameworks help manage authenticity concerns
3. Implementation is gradual rather than sudden
4. Professors maintain autonomy over how and when to use AI tools

B. The Virtuous Cycles of IA Integration

The interview data reveals several potential virtuous cycles in AI integration that positively impact psychological well-being. A primary virtuous cycle emerges where efficiency gains lead to stress reduction, which in turn facilitates better work-life balance, as one professor explained: *"This time saving translates into better organization of my work, a reduction in mental load, and therefore greater availability for moments of relaxation, reflection or family life."* This cycle appears strongest when the time saved is consciously redirected toward personal well-being rather than simply filling with additional work tasks. A second virtuous cycle involves how AI-enhanced output quality can increase professional confidence and satisfaction: *"The time savings allow me to perform several tasks per day, with sharp and diversified content, this allows me to be more confident before each intervention. This seems to me to be a form of well-being."* This cycle connects to core aspects of professional identity and efficacy, suggesting that AI can enhance rather than threaten professional self-concept when implemented appropriately.

The interviews revealed several significant tensions that shape professors' psychological experiences with AI. A key tension exists between increased efficiency and developing technological dependency: *"By saving me precious time [...] it has allowed me to refocus on things with higher added value. [...] However, I also notice a form of dependency that is gradually setting in."* This tension reflects concerns about whether efficiency gains might come at the cost of professional autonomy and skill maintenance. Another tension exists between innovation benefits and the pressure of continuous technological adaptation: *"Improve the quality and personalization of pedagogical content [...] but sometimes additional pressure to 'stay up to date'."* This tension connects to the "techno-uncertainty" dimension of Digital Stress Theory, where rapid technological change creates ongoing adaptation demands.

Professors navigate a complex balance between technological assistance and professional autonomy: *"This reflects growing confidence in the tool, but also raises the question of the balance between autonomy and technological assistance."* This tension appears particularly salient in

academic contexts where professional identity is closely tied to intellectual autonomy and expertise. These psychological tensions and ambivalences suggest that while AI integration offers significant benefits for professor well-being, successful implementation requires careful attention to maintaining professional agency and managing adaptation pressures to prevent the emergence of problematic dependencies or stress responses.

XXII. CONCLUSION

This study explored the impact of AI tools on the psychological well-being of university professors in Morocco through qualitative interviews with 17 participants, revealing a complex relationship where AI simultaneously functions as both a resource and a demand in professors' professional lives. Key findings demonstrate that AI tools significantly reduce work-related stress for many professors by automating repetitive tasks, enhancing efficiency, and improving output quality, creating virtuous cycles where efficiency leads to stress reduction and better work-life balance, while quality enhancement increases professional confidence and satisfaction. Four distinct psychological profiles emerged in professors' experiences with AI: "Optimizers," "Balancers," "Vigilants," and "Ambivalents," each with different psychological benefits and challenges, alongside several psychological tensions between efficiency and dependency, innovation and adaptation pressure, and assistance and professional autonomy.

The research extends both the Job Demands-Resources model and Digital Stress Theory by illustrating how technological tools can simultaneously function as both resources and demands, with their net impact on well-being depending on implementation approaches and individual factors. The findings provide nuanced insights into how different dimensions of digital stress manifest in academic contexts, particularly highlighting "techno-complexity," "techno-uncertainty," and emerging "techno-dependency" concerns, while revealing how these stressors interact with professional identity and autonomy in knowledge-intensive academic roles. Contextual factors in the Moroccan setting, including infrastructure limitations and cultural perspectives on technology, shape psychological experiences in ways that differ from Western educational contexts, with ethical concerns creating significant "ethical cognitive load" for professors regarding content authenticity, algorithmic bias, and student over-reliance on AI.

The practical implications suggest that universities should develop personalized support approaches recognizing diverse psychological responses to AI, implement clear ethical

frameworks to reduce cognitive load on individual professors, and adopt phased implementation strategies with adequate adjustment periods to reduce adaptation stress. The most psychologically beneficial implementations appear to be those that enhance resources without creating overwhelming new demands, preserve professional autonomy, and align with core academic values, emphasizing AI as a complement to rather than replacement for faculty expertise. As one professor noted, "*Professional fulfillment directly impacts personal life*," highlighting why thoughtful, psychologically-informed approaches to AI integration matter not just for educational outcomes, but for the human experience of those who dedicate their careers to higher education, demonstrating that successful technology integration requires attention to both technical capabilities and the psychological well-being of educators.

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Examining the Incorporation of AI in Academic Research: The Instance of Higher Education in the Marrakech-Safi Region

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Abstract

This paper examines the incorporation of Artificial Intelligence (AI) technologies in academic research within the Marrakech-Safi region of Morocco, with a specific focus on their use by university academics. This research examines the prospects, challenges, and ethical considerations surrounding the adoption of AI in Moroccan higher education institutions, conducted through semi-structured interviews with academics at Cadi Ayyad University. The research indicates that AI is significantly enhancing research productivity, fostering interdisciplinary collaboration, and providing novel solutions to emerging academic challenges. Nonetheless, other challenges persist, including deficient infrastructure, poor training, and the absence of comprehensive policies to govern AI use. The article concludes with policy recommendations aimed at enhancing the efficient implementation of AI for the optimisation of research methods in the region.

Keywords: Artificial Intelligence, Education Policy, Higher Education, Research Methods

XXIII. INTRODUCTION

Artificial Intelligence (AI) is rapidly evolving as a transformative influence in higher education, offering solutions to persistent challenges in education, research, and administration globally. The incorporation of AI technology into academic research holds tremendous prospects for enhancing productivity, promoting diverse collaboration, and stimulating creativity in research methodologies. In Morocco, including within the Marrakech-Safi region, the adoption of AI in higher education is in its early stages. Although institutions in this region are beginning to explore artificial intelligence (AI) tools for improved studies, issues concerning faculty training facilities and policy development remain prevalent.

This research aims to investigate the integration of AI technology by academic researchers in higher education institutions within the Marrakech-Safi region. The article examines the use of AI, the opportunities it presents for enhancing research productivity and quality, and the challenges researchers encounter when employing these technologies. The study examines the ethical and policy

implications of using AI in academic research. It offers practical recommendations for its effective and responsible implementation in universities across the region.

Conceptual Background

From a global perspective, the use of AI in research has brought about a new revolution, driving new methods and breakthroughs in numerous fields. Here in Morocco, this technological shift is still pending. At universities like Cadi Ayyad University (Marrakech-Safi Region), scientists are adopting AI to enhance their research. Nonetheless, the local implementation of AI within these academic settings presents unique challenges, particularly regarding infrastructure, resource allocation, and the development of suitable regulations.

Research Problem

Although an increasing number of international studies examining the AI's contribution to enriching the academic research process exist, the interface of AI within Moroccan academic institutions, particularly in the Marrakech-Safi region, remains understudied. As a result, there are few studies regarding the unique challenges or opportunities within this regional context. This paper aims to close this gap by analyzing the current status of AI adoption in the country's universities, its effects on research practices, and the challenges that need to be addressed for its effective embedding.

Research Objectives and Questions

Hypotheses:

- **First hypothesis:** The use of AI tools in academic research in the Marrakech-Safi region has a significant influence on the research productivity and interdisciplinary collaboration among researchers.
- **Second hypothesis:** The integration of AI in universities within the Marrakech-Safi region encounters substantial obstacles, including limited infrastructure, insufficient faculty training, and a lack of comprehensive policies governing AI utilisation in academic research.

Research Question:

Based on the previously stated hypotheses, the main research question is:

- **How does Artificial Intelligence currently impact teaching and research at universities in the region of Marrakech-Safi, as well as the emerging opportunities, challenges, and ethical issues associated with its introduction?**

This study aims to elucidate the adoption of AI in higher education institutions within the Marrakech-Safi region and to propose policy recommendations for enhancing its incorporation into academic research.

LITERATURE REVIEW

AI in Higher Education: Global and Local Contexts

Artificial Intelligence (AI) technology has gradually become integrated into international higher education institutions, transforming various areas of academic research. The implementation of AI enables institutions to optimize procedures, enhance academic efficiency, and develop innovative study methods. Applications of AI in higher education include data analysis, personalised learning, digitisation of administrative tasks, and the promotion of substantial collaborative studies (Luckin et al., 2016). In addition, AI is enhancing the ability to quickly process and analyze large datasets, thereby increasing the speed and accuracy of research findings (Brynjolfsson & McAfee, 2014).

The global impact of AI on the academic sector is widely documented, with numerous studies highlighting its importance in enhancing productivity and promoting diverse approaches to addressing complex academic challenges. AI-driven methods in academic research have facilitated expedited data processing and enhanced prediction models, especially in disciplines such as healthcare, engineering, and social sciences (Chui et al., 2016). This global perspective on AI's influence underscores its potential to transform academic research and boost overall productivity.

The National Strategy for Digital Education (2018) in Morocco established the foundation for integrating AI tools into educational environments, emphasizing the enhancement of digital infrastructure and the deployment of AI in universities (El Khamlichi, 2019). Nevertheless, notwithstanding these endeavors, Moroccan institutions, particularly in less urbanized areas like Marrakech and Safi, persist in encountering difficulties. This encompasses limited access to sophisticated AI tools, inadequate infrastructure, and a deficiency in specialised training for teachers and researchers (Benmansour et al., 2021). Nonetheless, promising signs of progress are emerging. Institutions such as Cadi Ayyad University in Marrakech have begun integrating AI technologies into research methodologies, specifically to enhance research output and promote cross-disciplinary cooperation.

Global AI in Education Market, By Region, 2018-2022 (USD Million)

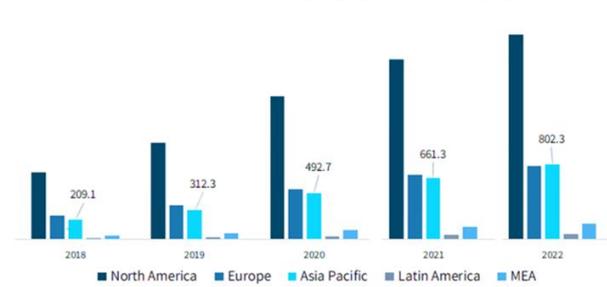


Figure 1: Global AI Adoption in Higher Education

Opportunities for AI in Academic Research

Artificial Intelligence presents numerous opportunities to enhance both the effectiveness and quality of research at Moroccan universities. Machine learning (ML), natural language processing (NLP), and data mining are essential AI technologies used to automate repetitive processes, analyze extensive datasets, and support literature reviews and data interpretation (Chui et al., 2016). These tools enable researchers to analyze complex datasets efficiently, reveal hidden patterns, and gain insights that would otherwise be laborious or challenging to identify through conventional methods.

Researchers across various disciplines, including engineering, economics, and social sciences, are utilising AI to achieve expedited insights and generate more dependable and significant study results. AI applications in economics facilitate the analysis of extensive economic data, thereby informing policy decisions. In the social sciences, AI is used to analyze sentiment in social media and historical data, providing valuable insights into community patterns. Furthermore, AI's capacity to break down disciplinary boundaries enables interdisciplinary collaboration, with AI technologies serving as bridges connecting diverse academic fields. Researchers are gradually implementing AI to tackle complex social issues, such as climate change, public health, and urbanization (Brynjolfsson & McAfee, 2014). By automating data analysis, AI systems liberate academics from mundane tasks, enabling them to focus on more intellectual and creative aspects of their work.

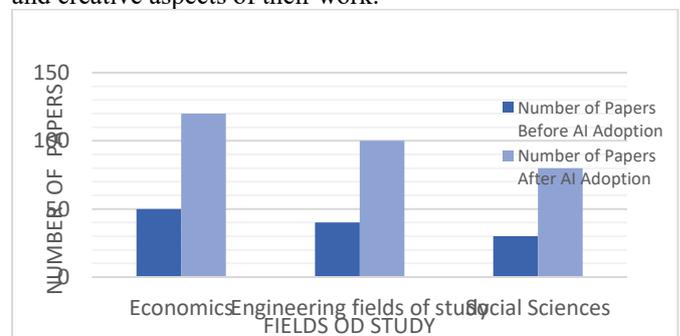


Figure 2: AI's Impact on Research Productivity and Collaboration

The diagram above illustrates the role of Artificial Intelligence (AI) in enhancing research productivity across various academic disciplines. The bar chart illustrates the quantity of academic articles published before and after the adoption of AI in disciplines such as economics, engineering, and social sciences. It illustrates a distinct rise in research productivity, particularly in economics and engineering, where AI tools have presumably facilitated more efficient data analysis, expedited research cycles, and enhanced collaboration. This visual depiction emphasises the revolutionary impact of AI on research productivity and illustrates its potential to foster innovation in academic disciplines.

Ethical and Social Implications of AI in Research

Although AI offers considerable advantages for academic research, it also presents various ethical and social challenges that require resolution to ensure its responsible use. A major issue is data privacy. Artificial intelligence tools often rely on extensive datasets, some of which may contain sensitive or personally identifiable information. Researchers employing AI must ensure that their data collection and processing methods adhere to ethical norms and privacy regulations, thereby preventing the potential misuse of personal data (O'Neil, 2016).

Another issue is the possibility of algorithmic bias, in which AI systems may inadvertently reinforce existing societal biases inherent in the data. AI techniques employed in social science research may yield biased outcomes if the training data is inadequate or distorted (O'Neil, 2016). This concern is especially critical in fields such as education and healthcare, where biased algorithms may yield substantial societal and policy consequences.

The necessity for ethical transparency and accountability in AI development is critical. Concrete standards must be developed for AI implementation to guarantee that research methodologies employing AI tools are both responsible and equitable. Researchers and entities must establish comprehensive frameworks to tackle issues such as bias, transparency, and the ethical utilisation of data (Gasser et al., 2018). Moreover, the enduring societal ramifications of AI-driven research necessitate ongoing scrutiny to ensure that the technology serves all stakeholders equally, without exacerbating existing gaps.

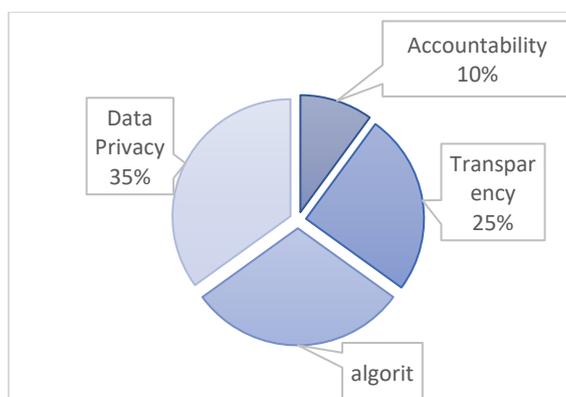


Figure 3: Ethical Concerns in AI-Driven Research

The pie chart above illustrates the allocation of principal ethical issues recognised in AI-driven research. Data privacy (35%) and algorithmic bias (30%) are the primary concerns, underscoring the growing emphasis on safeguarding sensitive information and promoting equity in AI systems. Transparency (25%) and accountability (10%) are significant concerns, underscoring the need for clear and accessible information on AI systems and the importance of ensuring accountability for AI-driven activities. These findings underscore the need to establish comprehensive ethical frameworks that govern the responsible application of AI in academic research.

XXIV. RESEARCH DESIGN AND METHODOLOGY

A. Research Approach

This study employs a qualitative research methodology, utilizing a case study design, to investigate the incorporation of Artificial Intelligence (AI) in academic research at two universities in the Marrakech-Safi region, specifically Cadi Ayyad University. This study's qualitative nature facilitates a comprehensive knowledge of the utilisation of AI technologies in academic research, highlighting both the benefits they offer and the limitations they confront. This method facilitates a detailed examination of the ethical and policy ramifications of AI implementation, as viewed by academic experts.

The semi-structured interview method served as the primary data collection instrument, providing participants with the flexibility to articulate their perspectives on AI integration in research while maintaining coherence with the study's central themes.

B. Data Collection

A defined questionnaire has been created and delivered over Google Forms to collect data. This approach enabled extensive access and the effective collection of both quantitative and qualitative data. A total of 204 respondents from Cadi Ayyad University and Sidi Mohamed Ben Abdellah University (formerly known as Safi University) completed the questionnaire. The comments offer a comprehensive analysis of AI implementation and its challenges within these institutions.

The questionnaire comprised eight theme components, detailed as follows:

1. General Information: This section collected fundamental demographic data, including gender, age category, academic level (undergraduate, master's, PhD, or university lecturer/researcher), and prior experience with AI training.

2. AI Adoption and Use: Participants were inquired about the AI tools employed in their research (e.g., ChatGPT, Google Bard/Gemini, Claude, Microsoft Copilot), their usage frequency, and the perceived advantages (e.g., data analysis, writing support). Challenges, including insufficient training, restricted access, and ethical dilemmas, were also analysed.

3. Opportunities for AI in Research: This section examined participants' perceptions regarding the potential of AI to enhance research productivity and quality in Moroccan universities.

4. Policies and Institutional Support: Participants inquired about the existence of AI-supportive policies and initiatives within their institutions, encompassing training, research funding, and access to AI tools.

5. Ethical and Social Implications: Participants emphasised their ethical apprehensions regarding AI in research, encompassing data privacy, algorithmic bias, and transparency challenges.

6. Future Prospects: This section examined participants' perspectives on the future of AI in Moroccan higher education and research, along with suggestions for enhancing AI integration.

7. Open Comments: Participants had the option to offer supplementary feedback, discuss experiences, or propose suggestions regarding AI in academic research.

Data were gathered electronically through Google Forms, facilitating an organised and efficient approach. The survey's voluntary and anonymous format encouraged honest feedback, while the broad representation of academic levels and disciplines ensured a diverse range of viewpoints on AI adoption.

Semi-Structured Interviews

In addition to the questionnaire, semi-structured interviews were conducted to explore further the key themes identified in the literature and from survey data. The semi-structured format allowed for flexibility, enabling participants to elaborate on their experiences and insights while addressing predetermined questions on:

- 1. AI Adoption and Use:**
 - What AI tools do you use in your research (e.g., ChatGPT, DeepSeek, Google Bard/Gemini)?
 - How do these tools enhance your research practices?
 - What challenges have you encountered in adopting AI tools?
- 2. Opportunities for AI in Research:**
 - Do you believe AI can improve research productivity and quality in Moroccan universities?
 - Can AI tools help solve specific research challenges in your field?
- 3. Policies and Institutional Support:**
 - Are there AI-supportive policies at your university?
 - What resources (e.g., training, funding, AI tools) does your university offer to support AI adoption?
- 4. Ethical and Social Implications:**
 - What ethical concerns do you associate with AI in research (e.g., data privacy, algorithmic bias)?
 - How do you address these ethical concerns in your own research?
- 5. Future Prospects:**
 - How do you envision the future of AI in Moroccan higher education and research?
 - What steps should universities take to promote responsible and effective AI integration?

C. Data Analysis

The data collected through interviews and the survey were subjected to thematic analysis, an approach appropriate for qualitative research. This study discovered reiterating concepts and trends, which have been divided into principal categories comprising AI adoption challenges, ethical considerations, and institutional support. The thematic analysis provided significant insights into the barriers and prospects associated with AI integration in Moroccan higher education, hence influencing the study's recommendations for improved AI adoption.

XXV. RESULTS AND DISCUSSION

AI Tools in Use

The findings indicate that researchers in multiple fields in the Marrakech-Safi region are steadily embracing artificial intelligence (AI) methods. Researchers at Cadi Ayyad University are employing machine learning algorithms and advanced data analysis platforms to analyze and interpret vast datasets, particularly in the fields of economics, engineering, and environmental sciences. At UCA University, artificial intelligence technologies are utilized for various administrative and academic purposes, including automating grading procedures, streamlining student exams, and efficiently handling research data.

Table 1 : Word Frequency

Word	Length	Count	Weighted Percentage (%)	Similar Words
training	8	243	4,62	training
research	8	225	4,28	research, researchers, researches
chatgpt	7	171	3,25	chatgpt
funding	7	158	3,00	funding
support	7	146	2,78	support, supportive
tools	5	139	2,64	tool, tools
centers	7	138	2,62	centers
access	6	134	2,55	access
software	8	134	2,55	software
offer	5	121	2,30	offer
create	6	117	2,23	create
help	4	116	2,21	help, helpful, helping, helps
writing	7	113	2,15	writing
saving	6	111	2,11	saves, saving
time	4	111	2,11	time
ethics	6	108	2,05	ethical, ethics
summarizing	11	108	2,05	summarizing
lack	4	105	2,00	lack
data	4	95	1,81	data
analysis	8	94	1,79	analysis

limited	7	93	1,77	limited, limites
faster	6	89	1,69	faster
deepseek	8	85	1,62	deepseek
gemini	6	81	1,54	gemini
improve	7	81	1,54	improve, improves, improving
bard	4	80	1,52	bard
google	6	80	1,52	google
results	7	72	1,37	result, results
accurate	8	71	1,35	accurate
copilot	7	71	1,35	copilot
microsoft	9	71	1,35	microsoft
workshops	9	66	1,26	workshops
collaborations	14	65	1,24	collaboration, collaborations
guidelines	10	63	1,20	guidelines
international	13	63	1,20	international
policies	8	63	1,20	policies
projects	8	61	1,16	project, projects
none	4	57	1,08	none
increase	8	52	0,99	increase, increasingly
institutional	13	52	0,99	institutional, institutions
cost	4	47	0,89	cost
issues	6	47	0,89	issues
legal	5	42	0,80	legal
concerns	8	41	0,78	concerns
challenges	10	33	0,63	challenges
technical	9	32	0,61	technical
focused	7	24	0,46	focus, focused
needs	5	24	0,46	need, needs
nothing	7	23	0,44	nothing
labs	4	22	0,42	labs
done	4	21	0,40	done
claude	6	20	0,38	claude
use	3	16	0,30	use, used, useful
academic	8	15	0,29	academic

The table above illustrates the frequency of essential terms identified in the study's data sources. These expressions highlight the key themes of the research, especially the relevance of Artificial Intelligence and AI within the realm of academic enquiry. The repeated use of terms such as 'data,' 'obstacles,' and 'adoption' underlines the study's primary focus on the integration of AI into research methodologies and the associated barriers to its implementation. This frequency analysis elucidates the principal problems and

focal points of interest within the academic community regarding AI in the Marrakech-Safi region.

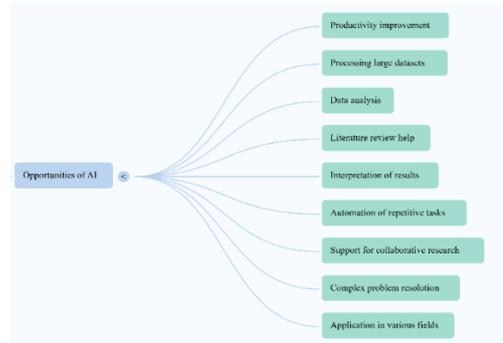


Figure 4: Textual Analysis of AI Opportunities in Research

The figure above illustrates one of the primary themes identified through the textual analysis of participants' responses regarding the potential of AI in academic research. The analysis identifies multiple persistent opportunities, including increased research productivity, interdisciplinary collaboration, and expanded data analytics skills. The graphic portrayal underscores the prevailing views of AI as a mechanism for expediting research processes, enhancing data management efficiency, and encouraging collaboration across diverse academic disciplines. The study highlights the increasing optimism regarding AI's capacity to foster innovation in research methods.

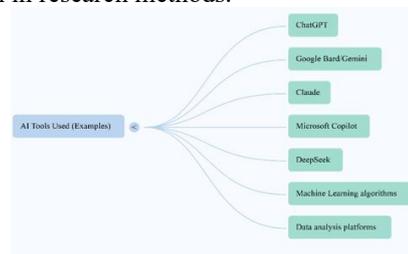


Figure 5 : AI Tools Used

The figure above shows an array of AI technologies commonly used by researchers in the Marrakech-Safi region. The apparent tools, including ChatGPT, Google Bard/Gemini, and Microsoft Copilot, illustrate a range of applications utilised for diverse academic functions, such as data analysis, writing support, and research administration. This picture illustrates the diversity of AI tools employed across several fields, showcasing the extensive functions these tools provide to facilitate academic research. The rising utilisation of these technologies highlights the escalating dependence on AI to improve productivity and effectiveness in studies.

Challenges in AI Adoption

Although there were positive effects, several issues were highlighted by the interviewees. The significant challenges are the lack of training programmes and knowledge about AI among instructors and researchers. A wide range of participants indicated a lack of formal education in AI, which impeded their ability to use these tools proficiently. Furthermore, the excessive expense of AI software and the

inadequate infrastructure, especially in rural portions of the region, prevented substantial AI adoption.

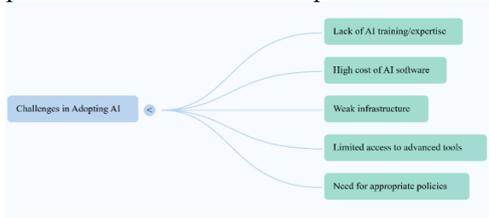


Figure 6 : Challenges of AI Adoption

The representation above illustrates the primary obstacles faced by researchers in the Marrakech-Safi region in integrating artificial intelligence (AI) methods into their academic endeavors. Common barriers, notably inadequate instruction, inadequate facilities, and ethical dilemmas, dominate the responses, highlighting the challenges institutions face in fully integrating AI into their research methods. The graphic depiction of these issues underscores the need for targeted initiatives, including enhanced training programs, increased access to AI resources, and more straightforward ethical guidelines, to overcome these barriers and promote widespread AI integration in academic research.

Ethical and Social Implications

Ethical considerations were a predominant subject in the interviews. Participants expressed concerns about the potential for bias in artificial intelligence (AI), particularly in research domains that involve human subjects. Researchers have raised concerns about the security of personal data when utilizing artificial intelligence (AI) methods to analyze sensitive academic and educational data. Most interviewees emphasised the need for specific ethical norms to regulate the use of AI in research.

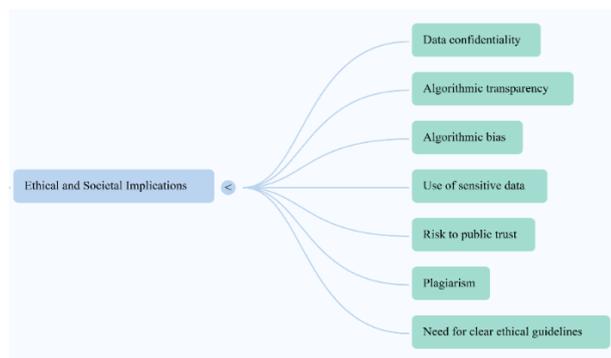


Figure 7 : Ethical and Social Implications

The diagram above illustrates the principal ethical and social implications associated with the application of AI in academic research, as recognized by participants from the Marrakech-Safi region. Issues including data privacy, algorithmic bias, and transparency are extensively emphasised, underscoring the increasing necessity for explicit ethical rules in AI implementation. These concerns highlight the potential dangers AI presents to research

integrity and social equality, underscoring the necessity of establishing responsible AI practices. The number underscores the imperative of tackling these ethical considerations to ensure that AI can be used effectively and ethically within educational institutions.



Figure 8: Word Cloud Visualization

The word cloud above illustrates the most frequently cited terms in the article, emphasizing key concepts and topics related to AI adoption in academic research. Keywords such as AI tools, data, research, and challenges are prevalent, highlighting the key topics of discussion among participants. The dimensions of each word align with its frequency, providing an easy-to-understand visual representation of the main issues and prospects related to AI integration. This word cloud provides a concise overview of the domains that require additional focus and research on AI's involvement in academic research.

CONCLUSION AND POLICY RECOMMENDATIONS

This study has demonstrated that Artificial Intelligence (AI) holds considerable promise for transforming research methods in Moroccan universities, particularly in the Marrakech-Safi region. Artificial intelligence tools can improve research efficiency, promote multidisciplinary cooperation, and optimise intricate data processing procedures. The effective integration of AI into higher education systems depends on addressing various obstacles, including those related to infrastructure, training, and ethical concerns. The constraints mentioned in the study impede the complete actualisation of AI's potential in academic research. The results underscore the need for a systematic and thorough approach to AI implementation in Moroccan universities. As AI technologies advance and influence research approaches worldwide, Moroccan institutions must establish frameworks that address the challenges outlined in this study. Given these findings, the subsequent policy recommendations have been proposed to promote appropriate and successful integration of AI into research methods:

- 1. Establish AI Training Programmes:** Universities must prioritise the development of specialised training initiatives to enhance AI literacy among academics and researchers. These programmes should focus on training academic experts with the requisite skills to proficiently employ AI tools,

thereby enabling them to leverage these technologies to enhance their scholarly endeavours fully. These programmes must be tailored to support researchers of differing expertise, ranging from beginners to experienced researchers.

2. Establish Explicit Ethical Guidelines: In light of the ethical issues related to the integration of AI in research, Moroccan universities must formulate and enforce definitive ethical frameworks that regulate the proper use of AI tools. These rules must tackle essential concerns, including data privacy, algorithmic equity, and transparency in AI-driven research. Adopting these moral standards will mitigate potential hazards, including biased algorithms and privacy violations, while fostering trust in AI applications within the scientific community.

3. Allocate resources towards AI infrastructure: For the successful utilisation of AI tools, it is imperative that both the government and institutions invest in AI infrastructure. This entails enhancing access to advanced computing resources, supplying AI-specific software, and establishing research centres focused on AI. By fostering an enabling environment for AI research, institutions can equip researchers with the essential tools and resources necessary for making significant academic contributions. These investments will also facilitate the advancement of AI-driven advances that can enhance worldwide academic knowledge.

By focusing on these critical areas, Moroccan institutions can more effectively integrate AI technology into their research methodologies, thereby enhancing their research output and contributing to the global corpus of academic knowledge. The effective integration of AI would not only stimulate innovation in research but also establish Moroccan higher education institutions as leaders in the worldwide academic field.

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Decentralized Governance and Strategic Alignment in Hypo-Groups: An Empirical Analysis in the Moroccan Context

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Abstract

This study examines the impact of strategic, financial, and organizational autonomy of subsidiaries on strategic alignment within Moroccan hypo-groups, using a quantitative approach based on a sample of 246 managers. The findings reveal that both strategic and financial autonomy significantly weaken coherence with headquarters' objectives, whereas HR autonomy shows no significant effect, highlighting the stabilizing role of informal mechanisms. These insights offer renewed theoretical perspectives on decentralized structures by incorporating the specificities of transitional contexts.

Keywords

Hypo-groups, strategic alignment, subsidiary autonomy, hybrid governance, quantitative analysis, emerging economies.

I. Introduction

In the face of a globalized and uncertain economy, hypo-group networks of autonomous companies linked by flexible coordination—are emerging as underexplored organizational structures. They are characterized by low integration, significant decentralization, and substantial subsidiary autonomy, posing challenges in terms of governance, strategic alignment, and coordination.

Decentralized autonomy within hypo-groups enhances responsiveness to diverse local environments and facilitates the development of localized competencies. However, in the absence of coherence mechanisms, it may lead to strategic misalignment and fragmentation. Striking a balance

between autonomy and coherence thus represents a major governance challenge.

This study proposes a framework for analyzing how decentralized governance influences strategic alignment within hypo-groups. Drawing on agency theory, embeddedness, and hybrid governance models, it investigates the impact of decision-making autonomy on strategic, financial, and organizational dimensions. The article is divided into two parts: the first explores decentralized governance and its inherent tensions, while the second examines mechanisms that promote effective alignment, such as coordination, trust, and regulatory frameworks. The aim is to shed light on management practices within these structures, particularly in transitional economies such as Morocco.

II. LITERATURE REVIEW

A. Decentralized Governance in Hypo-Groups: Between Decision-Making Fragmentation and the Pursuit of Strategic Coherence

1. An Atypical Organizational Architecture: Decentralization as the Foundation of Hypo-Groups

The structure of hypo-groups is characterized by the absence of a single decision-making center, in contrast to integrated corporate groups. According to Taghzouti, Babounia, and Bennani [2025], this model is rooted either in an entrepreneurial logic that values local autonomy or in legal, fiscal, or cultural constraints. Whether voluntary or imposed, this decentralization complicates governance by hindering smooth centralized strategic coordination. Each

subsidiary becomes a fully-fledged decision-making center, developing its own trajectory based on its resources, market, and institutional environment.

This configuration fosters a redistribution of strategic power, thereby challenging the relevance of traditional models based on vertical hierarchy and centralized control. Embeddedness theory [FasterCapital, 2025], combined with agency theory [Jensen & Meckling, 1976], provides a framework for analyzing how local managers may develop strategic autonomy, which can lead to misalignment with the group's overarching objectives. The associated risks are both organizational (loss of strategic coherence) and economic (inefficiencies due to duplication of efforts).

However, decentralization also presents opportunities. As noted by FasterCapital [2025], a multi-centered organization enhances local adaptability, fosters innovation, and increases the engagement of operational stakeholders. Subsidiaries with decision-making autonomy tend to be more responsive to environmental changes and can develop strong local leadership, particularly in sectors that are highly influenced by cultural or regulatory contexts, such as retail or healthcare.

The implementation of hybrid governance—combining flexible control mechanisms (e.g., reporting systems, performance-based evaluations, dashboards) with significant decision-making latitude—emerges as a strategically relevant response [Taghzouti et al., 2025]. Such an approach may enable a balance between global strategic coherence and local operational efficiency by strengthening horizontal coordination and learning circuits. In emerging contexts such as Morocco, this model holds relevance. The diversity of institutional environments, the relative weakness of inter-organizational information systems, and the prominence of informal networks reinforce the need to adapt governance structures to local realities. As such, a dynamic governance model that empowers subsidiaries while being framed by flexible instruments may represent an effective pathway for managing these hypo-groups.

2. Three Forms of Autonomy: Strategic, Financial, and Organizational

Subsidiary decision-making autonomy unfolds across several dimensions, notably strategic, financial, and organizational autonomy. Each reflects a specific trade-off between centralization and decentralization.

Strategic autonomy refers to the subsidiary's ability to define its own development trajectory, including market selection, segmentation, product offerings, and partnerships [Lawton et al., 2024]. This autonomy is particularly vital in uncertain or culturally distinct local environments. Birkinshaw and Morrison [1995] emphasize that such subsidiaries can become "centers of excellence," generating distinctive and innovative capabilities that may serve as drivers of transformation for the entire group.

Financial autonomy denotes the capacity to manage resources independently of the headquarters, including local budgeting, investment decisions, and funding arrangements [Gates & Egelhoff, 1986]. While enhanced financial autonomy can improve operational efficiency, it requires

organizational maturity and appropriate control mechanisms [O'Donnell, 2000].

Organizational autonomy pertains to internal management, including recruitment, training, and managerial routines [Ferner et al., 2004]. It is essential for tailoring management practices to local contexts while preserving overall coherence. However, excessive autonomy in this domain can lead to divergent HR practices, potentially undermining cultural integration and the diffusion of capabilities.

These forms of autonomy are interdependent and dynamic, shaped by ongoing negotiations between headquarters and subsidiaries [Bouquet & Birkinshaw, 2008].

3. Autonomy and Strategic Misalignment: An Ambivalent Relationship

The relationship between autonomy and strategic misalignment is complex. According to agency theory [Jensen & Meckling, 1976], increased autonomy may foster opportunistic behavior, potentially leading to deviations from the group's overarching objectives. While the literature suggests that strategic autonomy enhances creativity and local responsiveness [Birkinshaw & Hood, 1998], it can also result in divergence from the global strategy—particularly in multicultural or institutionally complex contexts [Ghoshal & Nohria, 1989].

Several hypotheses can be proposed [H1, H2, H3]:

H1: The higher the level of strategic autonomy of subsidiaries, the lower the strategic alignment with the headquarters.

H2: The higher the level of financial autonomy of subsidiaries, the lower the strategic alignment with the headquarters.

H3: The higher the level of autonomy in human resource management, the lower the strategic alignment with the headquarters.

These relationships, however, are contingent upon coordination mechanisms, mutual trust, and the specific context. Effectively managing these tensions requires a balanced approach that combines autonomy with regulation [Bouquet & Birkinshaw, 2008].

B.Strategic Alignment in Multi-Business Groups: Mechanisms and Vulnerabilities

In hypo-group structures, where vertical coordination is intentionally or structurally weakened, the central challenge lies in the ability to maintain strategic alignment between subsidiaries and the headquarters. Far from being mere compliance with group directives, strategic alignment entails a deep coherence of orientations, objectives, and actions deployed across all levels of the organization (Venkatraman & Henderson, 1993).

1. Strategic Alignment and Multi-Level Governance: Tensions Between Formal and Informal Mechanisms

Strategic alignment refers to the degree of convergence between the strategy formulated by a group's headquarters and the strategy actually implemented by its decentralized units, particularly its subsidiaries. It is not merely a matter of formal compliance, but rather a dynamic, evolving, and multidimensional process. This alignment is reflected in the capacity of different hierarchical levels to share common objectives, to construct coherent action plans, and

to synergistically articulate local decisions with those made at the center. Within this logic, vertical alignment—that is, the correspondence between the headquarters' strategic orientations and the subsidiaries' operational practices—plays a critical role in overall group performance, particularly in competitive and international contexts where strategic cohesion becomes a vital factor for survival (Bartlett & Ghoshal, 1989).

To achieve such alignment, groups rely on a range of formal mechanisms designed to structure and steer strategic action across all levels. Among the most commonly used are top-down strategic planning processes, which define the group's major orientations through structured and often annual cycles. These are supplemented by integrated management control systems, which monitor the execution of strategies via standardized dashboards. Harmonized key performance indicators (KPIs) ensure comparability of results among subsidiaries, while regular reporting fosters ongoing dialogue between headquarters and peripheral entities. These tools enhance mutual visibility and facilitate coordination around shared objectives.

However, such formal mechanisms are not always sufficient to ensure strategic coherence—particularly in structures marked by low integration, as is often the case in hypo-groups. In these settings, informal mechanisms play a complementary, and sometimes central, role in maintaining alignment. A shared corporate culture can serve as a collective frame of reference, providing actors with a common set of values and expected behaviors. Leadership from the headquarters—whether exercised through charismatic leaders or influential central teams—can help guide subsidiary practices without relying on coercive instruments. Moreover, networking among local managers—through cross-functional meetings, inter-subsidary working groups, or communities of practice—facilitates information flow and the development of a shared vision.

In hypo-groups, where formal tools may be partial, underdeveloped, or inconsistent, these relational and cultural mechanisms often constitute the primary coordination infrastructure. As Ferner et al. (2004) point out, it is precisely in such contexts that the ability to mobilize informal resources becomes strategically significant. Ultimately, strategic alignment results from a balance between formalism and informality, between codified procedures and human interactions, with each group needing to calibrate this mix based on its structure, degree of internationalization, and managerial resources.

2. Autonomy as a Source of Strategic Misalignment

As previously discussed, the autonomy granted to subsidiaries constitutes a valuable strategic resource, particularly in complex or highly differentiated local environments. It enables rapid adaptation, context-specific innovation, and stronger anchoring in local dynamics. However, when insufficiently regulated, this very autonomy can become a source of strategic misalignment between subsidiaries and headquarters. Several studies have emphasized that, in the absence of robust

coordination, control, and socialization mechanisms, local autonomy may lead to drift that compromises the group's overall coherence (Doz & Prahalad, 1987; O'Donnell, 2000).

More specifically, poorly regulated strategic autonomy may encourage subsidiaries to pursue their own trajectories—often shaped by local priorities that are not necessarily aligned with the global vision of the headquarters. This phenomenon, referred to by Birkinshaw and Hood (1998) as "entrepreneurial drift," describes the tendency of highly autonomous subsidiary managers to develop expansion or innovation strategies independently, and at times, in divergence from central orientations. In such cases, local agility can devolve into strategic fragmentation, undermining the convergence of actions at the group level.

From a financial perspective, budgetary autonomy, when not accompanied by cross-functional regulatory mechanisms, may result in inefficient local trade-offs from the group's standpoint. An autonomous subsidiary may favor its own projects, immediate profitability, or internal stability, at the expense of resource pooling, financial solidarity across entities, or the funding of collective initiatives. As Gates and Egelhoff (1986) note, such tendencies can weaken the group's capacity to undertake coordinated strategic investments.

Autonomy in human resource management, meanwhile, enhances the ability of subsidiaries to adapt to local institutional and cultural specificities. However, when this autonomy is excessive or entirely disconnected from group standards, it can result in heterogeneous managerial practices, undermining internal cohesion and talent mobility. Ferner et al. (2004) show that the absence of a coherent HR policy within a group may generate tensions, limit inter-subsidary synergies, and weaken the sense of belonging to a unified organization.

That said, this analysis calls for nuance: autonomy is not inherently a source of misalignment. Rather, it is the conditions under which it is exercised that determine its effects. When autonomy is embedded within flexible yet effective coordination mechanisms—such as shared frameworks, reporting routines, inter-organizational exchanges, or a common corporate culture—it can coexist harmoniously with strong strategic alignment. The real challenge for decentralized groups lies in combining local freedom of action with global coherence.

In the specific case of hypo-groups—often marked by low formalization, structural heterogeneity, and bottom-up entrepreneurial logic—this tension is particularly acute. The scarcity of formal strategic management tools makes informal mechanisms—such as trust, relational proximity, or central leadership—all the more crucial. In other words, in these hybrid structures, autonomy can generate collective value only when embedded within a stable relational and strategic framework.

Table 1: Theoretical Perspectives on Strategic Alignment

Authors (Year)	Main Theme	Key Arguments	Position / Conclusions
Taghzouti, Babounia & Bennani (2025)	Governance of subsidiaries in hypo-groups	Analysis using agency theory and embeddedness theory: local managers increase their discretionary power, weakening central control mechanisms	Position: local autonomy must be calibrated to limit agency costs and preserve strategic alignment. A theoretical model is proposed, adaptable to the Moroccan context.
Lawton, Angwin, Dattée, Arrègle & Barbieri (2024)	Autonomy as a dynamic variable in acquired subsidiaries	Framework with three "strategic levers": appraisal respect, organizational identity, and resource orchestration; subsidiaries must progressively earn headquarters' respect	Position: autonomy is gradually earned through performance and trust; excessive autonomy risks strategic desynchronization.
Ferner et al. (2004)	Balance between centralization and local decision-making in HRM in US multinationals in the UK	Case study shows oscillation between centralized policies and local autonomy; this balance is negotiated through micro-political processes between HQ and subsidiaries	Position: local autonomy fosters adaptation but must be negotiated and regulated to ensure overall strategic coherence.

Source : Autors

III. Research Design

This research adopts a hypothetico-deductive and quantitative approach, aiming to empirically test a conceptual framework developed from the literature on decentralized governance and strategic alignment in hypo-groups. The main objective is to analyze the influence of three forms of autonomy—strategic, financial, and organizational—on strategic misalignment between subsidiaries and headquarters, taking into account coordination mechanisms and the specific context (notably transitional economies such as Morocco).

The research design is based on a survey administered to a sample of managers and decision-makers from subsidiaries operating within Moroccan hypo-groups.

A. Field Selection and Target Population

The study focuses on Moroccan hypo-groups—decentralized structures combining subsidiary autonomy with strategic coordination. The target population includes operational executives (CEOs, financial and HR managers) from these subsidiaries, selected to reflect Morocco’s sectoral and geographical diversity. This setting enables an analysis of the balance between delegation and alignment in a context shaped by local specificities, such as informal networks and family governance.

B. Measurement Instrument

The structured questionnaire was designed specifically to test the three hypotheses (H1, H2, H3) regarding the impact of different types of autonomy on strategic alignment. The instrument is based on validated scales from the literature and includes the following sections:

Independent Variables (Autonomy):

Strategic Autonomy (H1):

- Ability to define market orientations (scale adapted from Lawton et al., 2024)
- Freedom in choosing local partnerships (Birkinshaw & Morrison, 1995)
- Level of initiative in innovation (Likert scale 1–5)

Financial Autonomy (H2):

- Control over operational budget (Gates & Egelhoff, 1986)
- Ability to carry out local investments without central approval (O’Donnell, 2000)
- Autonomous management of cash flows (Likert scale 1–5)

Organizational/HR Autonomy (H3):

- Freedom in recruitment and salary policies (Ferner et al., 2004)
- Adaptation of managerial practices to local context (Likert scale 1–5)

Dependent Variable (Strategic Alignment):

- Degree of convergence between local and global objectives (Ghoshal & Nohria, 1989)
- Perceived consistency of decisions with the headquarters’ vision (Likert scale 1–5)

C. Sampling Method and Data Collection

The sample will be constructed using a non-probability purposive sampling method, with the goal of ensuring sectoral diversity and organizational representativeness. The questionnaire will be administered through a hybrid approach: online (via Google Forms or Qualtrics) and in-person in select partner companies. The target is to collect at least 246 usable responses to allow for robust statistical analysis.

1. Operationalization of Variables

The operationalization of variables is a key step to ensure the validity and reliability of the measures used in this study. Theoretical concepts have been translated into measurable variables using scales adapted to the study’s context.

1.1 Dependent Variable: Strategic Alignment

To assess the degree of strategic alignment between subsidiaries and headquarters, the questionnaire includes four main items adapted from validated scales in the literature. These items capture both the convergence of objectives and operational coordination. The following table presents the selected indicators and their theoretical sources.

Table 2: Measurement of Strategic Alignment – Items and Theoretical Foundations

Measurement Item	Scale source
To what extent are your subsidiary’s strategic objectives aligned with those defined by headquarters?	Ghoshal & Nohria (1989); Birkinshaw & Morrison (1995)
To what extent do your subsidiary’s operational decisions reflect the group’s global strategy?	O’Donnell (2000); Bouquet & Birkinshaw (2008)
To what extent do you share a common vision with headquarters regarding long-term development?	Gates & Egelhoff (1986); Lawton et al. (2024)
How frequently are local strategic adjustments coordinated with headquarters?	Ferner et al. (2004); Lazarova et al. (2017)

Source : Autors

2.2 Independent Variable: Strategic Alignment

The study assesses three types of subsidiary autonomy—strategic, financial, and organizational—through specific items, each corresponding to a research hypothesis. The following table outlines the operational indicators and their theoretical foundations.

Table 3: Measurement of Subsidiary Autonomy Variables

Autonomy Dimension	Measurement Items	Theoretical Foundations
Strategic Autonomy (H1)	<ul style="list-style-type: none"> Ability to define market orientations Freedom in choosing local partnerships Level of initiative in innovation 	Lawton et al. (2024) Birkinshaw & Morrison (1995) Original scale (Likert 1–5)
Financial Autonomy (H2)	<ul style="list-style-type: none"> Control over operational budget Capacity to carry out local investments without approval Independent management of cash flows 	Gates & Egelhoff (1986) O’Donnell (2000) Original scale (Likert 1–5)

Organizational/HR Autonomy (H3)	<ul style="list-style-type: none"> Freedom in recruitment and salary policy Adaptation of managerial practices to the local context 	Ferner et al. (2004) Original scale (Likert 1–5)
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2. Reliability and Validity of the Measures

In this study, the reliability and validity of the measurement instruments were examined through a pre-test of the questionnaire conducted with a sample of 246 managers from subsidiaries within hypo-groups, randomly selected from the target population. The collected data were analyzed using SPSS software (version 26) to ensure the rigor and robustness of the results.

The internal consistency of the scales was assessed using Cronbach’s Alpha coefficient. The results indicate high reliability for the majority of measured dimensions, as shown in Table 4 below:

Table 4 : Reliability Results of the Scales

Item-Total Statistics				
Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach’s Alpha if Item Deleted
Align_str1	38,75	93,104	,737	,872
Align_str2	38,71	90,714	,734	,871
Align_str3	38,55	93,554	,701	,873
Aut_str1	38,63	89,720	,728	,871
Alig_str1	38,82	89,617	,752	,870
Alig_str2	39,06	102,266	,485	,884
Alig_str3	39,11	100,253	,435	,886
Alig_str4	38,69	93,178	,727	,872
Aut_fin1	39,24	109,024	,138	,893
Aut_fin2	39,15	99,739	,369	,890
Aut_fin3	39,29	98,681	,381	,890
Aut_grh1	39,14	91,763	,593	,879
Aut_grh2	39,00	88,482	,673	,875

Source: Results generated using SPSS (version 26) by the authors

These results confirm that items within each scale converge to measure the same construct. Furthermore, the correlations between dimensions are moderate, thereby supporting the conceptual independence of the scales (discriminant validity).

The reliability and validity analyses demonstrate high internal consistency and satisfactory validity for the scales measuring decision-making autonomy, subsidiary size, subsidiary age, financial independence of subsidiaries, environmental uncertainty, interdependence among subsidiaries, the manager’s experience, and the level of trust. These findings confirm the relevance and robustness of the instruments used in this research.

IV. Results and Discussion

A. Presentation of the Results

1. Overall Analysis of the Studied Relationships

1.1 The relationship between strategic alignment with headquarters and the strategic, financial, and organizational autonomy of subsidiaries:

The multiple regression analysis indicates that the overall model is statistically significant ($F(3,75) = 36.535, p < 0.001$), explaining 53.23% of the total variance in the dependent variable, decision-making autonomy ($R^2 = 0.594, adjusted R^2 = 0.609$). The standard error of the

estimate is 0.671, suggesting a good fit between the model's predictions and the observed values.

Table 5 : Model Summary

Model Summary ^b				
Model	R	R-squared	Adjusted R-squared	Standard Error of the Estimate
1	,744 ^a	,594	,609	,67181496
a. Predictors: (Constant), REGR factor score 1 for analysis 1, REGR factor score 1 for analysis 1, REGR factor score 1 for analysis 1				
b. Dependent Variable: REGR factor score 1 for analysis 1				

2.2 Contributions of the Predictors in the Multiple Regression Model:

The standardized coefficients (β) indicate that all three predictors included in the model contribute to strategic alignment (see Table 6). Strategic autonomy has the strongest effect ($\beta = 0.594$, $p < 0.001$), followed by financial autonomy ($\beta = 0.220$, $p < 0.001$). Organizational autonomy, however, does not show a statistically significant effect ($\beta = -0.018$, $p = 0.688$). Collinearity diagnostics confirm the robustness of the model, with tolerance indices equal to or greater than 0.6 and variance inflation factors (VIF) below 2.

2.3 Hypothesis Testing

The hypotheses formulated in this study were tested using multiple regression analysis. The results of the tests are presented in Table 2 and discussed below:

Table 6: Hypothesis Testing Results

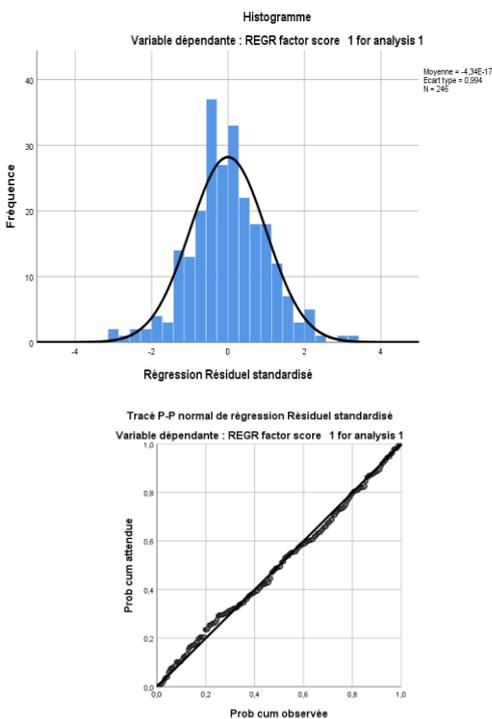
Hypotheses	β	t	p	Result
H1. The higher the level of strategic autonomy of subsidiaries, the lower the strategic alignment with headquarters.	0,594	8,613	,000	Supported
H2. The higher the level of financial autonomy of subsidiaries, the lower the strategic alignment with headquarters.	0,220	3,141	,002	Supported
H3. The higher the level of human resource management autonomy of subsidiaries, the lower the strategic alignment with headquarters.	-0,018	7,362	,000	Supported

Source: Data extracted by the authors using SPSS (v26)

2.4 Residuals and Model Validity

Residual diagnostics confirmed the validity of the model. The standardized residuals follow a normal distribution, as illustrated by the histogram (Figure 1), and the predicted values align closely with the observed values in the standardized residuals versus predicted values plot (Figure 2). No issues of heteroscedasticity or autocorrelation were detected.

Fig 1 : Histogram of standardized residuals



B. DISCUSSION OF RESULTS

H1. The higher the level of strategic autonomy of subsidiaries, the lower the strategic alignment with headquarters.

The results reveal a significantly positive influence of subsidiaries' strategic autonomy on their alignment with headquarters ($\beta = 0.594$, $p < 0.001$). This relationship supports the findings of Lawton et al. (2024) and Birkinshaw & Morrison (1995), suggesting that increased strategic autonomy tends to weaken strategic coherence between subsidiaries and headquarters. In the specific context of Moroccan hypo-groups, this phenomenon may be explained by:

The dynamics of local markets requiring rapid strategic adaptation

The complexity of Moroccan institutional environments
The emergence of local centers of excellence developing their own strategic orientations

H2. The higher the level of financial autonomy of subsidiaries, the lower the strategic alignment with headquarters.

The analysis reveals a significantly positive relationship between subsidiaries' financial autonomy and the weakening of strategic alignment with headquarters ($\beta = 0.220$, $p < 0.001$). This result corroborates the findings of Gates & Egelhoff (1986) and O'Donnell (2000), confirming that increased delegation of financial decision-making tends to reduce overall strategic coherence. In the Moroccan context, this dynamic is particularly explained by:

Decentralized management of local budgets and investments

Autonomous capacity for fundraising and cash management

Specificities of regional financial markets

The moderate magnitude of the coefficient ($\beta = 0.220$) suggests that although financial autonomy has a significant impact, it is less pronounced than the effect of strategic autonomy on misalignment. This finding aligns with Ferner et al. (2004), who emphasize the moderating role of financial control mechanisms.

H3. The higher the level of autonomy in human resource management, the lower the strategic alignment with headquarters.

Contrary to the initial hypothesis, the results show a non-significant relationship between HR autonomy in subsidiaries and strategic alignment ($\beta = -0.018$, $p = 0.688$). This absence of statistical correlation—surprising in light of previous literature (Ferner et al., 2004; Lazarova et al., 2017)—suggests that, in the Moroccan context:

Local HR policies seem to coexist with global strategy without generating major tensions

Decentralized management of recruitment and managerial practices does not appear to affect strategic coherence

Informal coordination mechanisms may compensate for formal discrepancies.

V. Conclusion and Managerial Implications

This study contributes to the understanding of decentralized governance and strategic alignment within hypo-groups, particularly in the context of emerging economies such as Morocco. Drawing on a sample of 246 subsidiary managers, the findings underscore the ambivalent effects of autonomy: while strategic and financial autonomy significantly weaken alignment with headquarters, HR autonomy does not exert a statistically significant impact. These results highlight the need for nuanced governance strategies that balance local responsiveness with overarching strategic coherence.

From a theoretical standpoint, the study enriches the literature on hybrid governance and subsidiary management by demonstrating that the effects of autonomy vary by dimension. The empirical support for the negative impact of strategic and financial autonomy reinforces the relevance of agency theory and embeddedness in explaining misalignment risks in decentralized structures.

Conversely, the absence of significant impact from HR autonomy suggests the stabilizing role of informal coordination mechanisms in culturally embedded contexts. From a managerial perspective, these insights offer several implications:

Calibrated Autonomy: Headquarters should tailor the level of autonomy granted to subsidiaries based on the type of decision involved. Strategic decisions require tighter coordination mechanisms to preserve alignment, whereas organizational decisions may tolerate more flexibility.

Strengthen Informal Mechanisms: In contexts where formal integration is limited, relational levers such as trust-building, shared culture, and frequent communication become essential tools for maintaining coherence across decentralized units.

Develop Hybrid Governance Tools: Implementing performance-based dashboards, cross-functional teams, and horizontal coordination platforms can mitigate the risks associated with excessive autonomy while preserving local initiative.

Contextual Adaptation: Emerging economies present specific challenges—including institutional variability and informal managerial practices—that require adaptive governance frameworks rather than one-size-fits-all solutions.

Future research could explore the longitudinal dynamics of strategic alignment in hypo-groups and examine whether digital transformation or AI-driven governance tools alter the autonomy-alignment relationship. For practitioners operating in transitional economies, this study offers a roadmap to manage autonomy as a strategic asset rather than a liability.

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Artificial Intelligence as an Educational Tool: Challenges and Opportunities for Teaching

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Abstract

Artificial intelligence (AI) is gradually being integrated into education, transforming teaching practices by enabling the automation of corrections, real-time content adaptation, and the creation of interactive environments. AI offers vast opportunities to personalize learning paths, enhance student engagement, and address the diversity of learner profiles. However, its use raises questions about its impact on teaching quality and student engagement. This study focuses on the perceptions of teachers and students regarding AI integration, aiming to understand its effects on teaching effectiveness and student engagement. The results indicate that AI improves the quality of teaching as perceived by teachers and enhances student engagement, although this largely depends on teacher training and available infrastructure.

Keywords

Artificial Intelligence, Pedagogical Tools, Student Engagement, Teaching Effectiveness, Perception of Teaching Quality.

XXVI. INTRODUCTION

Artificial intelligence (AI) is today emerging as a major lever for transformation in many fields, and education is no exception to this dynamic. Once seen as a cutting-edge technology reserved for research or industry, AI is now progressively entering higher education institutions, online learning platforms, and everyday pedagogical tools. From automated grading to real-time content adaptation based on the learner's profile, and the creation of interactive environments, AI offers significant possibilities to rethink the act of teaching and learning.

This technological evolution occurs in a context where expectations from education are continually rising: personalized learning paths, teaching effectiveness, student engagement, and the management of heterogeneous classes,

among others. In this framework, AI is often presented as an innovative solution capable of supporting the teacher while addressing the specific needs of learners.

However, the pedagogical use of artificial intelligence raises a significant question: How does the integration of AI into teaching practices influence the quality of teaching as perceived by teachers and student engagement in the learning process?

This study aims to explore the effects of artificial intelligence (AI) as a pedagogical tool on teaching practices and student learning, focusing on teachers' perceptions and learner engagement. More specifically, it seeks to:

Identify the extent to which AI usage influences teachers' perceptions of the quality and effectiveness of their teaching.

Measure the perceived impact of AI on student engagement, particularly in terms of attention, active participation, and motivation.

By addressing these objectives, this research aims to provide valuable insights for teachers, educational leaders, and technology developers, to support thoughtful, inclusive, and effective use of artificial intelligence in teaching.

XXVII. LITERATURE REVIEW

A. AI in the Educational Context

The integration of artificial intelligence (AI) into pedagogy is reshaping educational practices by offering personalized learning experiences and improving teaching effectiveness. AI technologies, such as intelligent tutoring systems and machine learning algorithms, facilitate adaptive learning and provide personalized feedback, which can significantly improve student engagement and outcomes (Liu et al., 2024; Solorzano et al., 2024).

However, challenges persist, including concerns about excessive dependence on technology, data protection, and the need for adequate teacher training (Talgatov et al., 2024; Taufikin et al., 2024). Research indicates that, while AI can enrich learning, it should complement, not replace, traditional

teaching methods to promote critical thinking and student autonomy (Talgatov et al., 2024).

Moreover, a bibliometric analysis highlights a growing body of publications on AI's transformative potential in education, suggesting that continuous development and ethical considerations are essential for effective integration (Okagbue et al., 2023). Thus, a balanced approach is crucial to leverage the benefits of AI while addressing the challenges it presents in educational environments.

B. Perception of Teaching Quality

Recent studies explore the perception and impact of artificial intelligence (AI) in higher education. Both students and teachers generally have a positive view of AI, recognizing its potential to improve teaching effectiveness and personalize learning (Bustamante Morán et al., 2025; Puente-Aguilar, 2025). While 80% of teachers consider AI useful for improving teaching, only 55% have received specific training (Bustamante Morán et al., 2025). Students show a strong interest in learning about AI, with 44% of them considering it essential to their academic training (Puente-Aguilar, 2025). AI enables real-time data analysis for personalized teaching and more precise evaluation (Jardón Gallegos et al., 2024). Overall, a responsible and ethical integration of AI can significantly contribute to the teaching-learning process.

The effectiveness of AI strongly depends on teachers' perceptions of educational technologies and their confidence in using them (Ayanwale et al., 2022; Chou et al., 2022; Lin, 2022). To improve teaching effectiveness, it is deemed crucial to improve teachers' perceptions of educational technologies (ET). It is increasingly evident that universities must create a culturally favorable environment for shared intelligence, encouraging teachers to use more modern pedagogical technologies, thus achieving more significant educational outcomes (Lin, 2022).

This is explained by the fact that AI-assisted teaching represents both progress and a gradual process. With adequate organizational support or a favorable classroom culture, teachers better perceive the real need for AI-assisted teaching, which motivates them and strengthens their confidence in implementing these practices, leading to better pedagogical effectiveness (Lin, 2022). Ahmad et al., (2021) studied the role of AI applications in education and found that social communication robots, intelligent learning, and intelligent teaching systems played an important role in improving the repetition of skill practices in learners. AI-assisted teaching can clearly improve teaching effectiveness by allowing teachers to develop more personalized teaching plans. Du Boulay, (2016) demonstrated that combining AI with teaching allowed teachers to better understand the essence of learning and teaching, and helped learners acquire new skills or better understand concepts.

In this continuity, teachers evaluate the effectiveness of AI-based products based on criteria such as precision, content creativity, and readability. AI-assisted inquiry-based learning enables curriculum integration, cooperative teaching, and integrated teaching strategies with ICTs, thereby promoting the development of critical thinking among students (Chou et al., 2022).

Moreover, the results of Moran's study (2025) show that teachers have a generally positive perception of the integration of artificial intelligence (AI) in teaching and learning processes. However, they also identify barriers, such as the lack of specialized training and limited technological resources. This emphasizes the need to design institutional strategies promoting digital literacy and continuous AI training for teaching staff. Teachers recognize AI's transformative potential in education, but their in-depth understanding and practical application remain limited (Aghaziarati et al., 2023). Additionally, recent research indicates that teachers' attitudes toward AI are influenced by their familiarity with the technology and their perception of its relevance in the educational context (Mutanga et al., 2024). Various studies have investigated teachers' perceptions of AI in education. Infante (2023) conducted research at the Urdesa Higher Technological Institute in Guayaquil, revealing that a large percentage of teachers have a positive view of AI, recognizing its potential to enrich the educational process. However, a lack of adequate training was also identified, limiting its effective implementation. On the other hand, Basantes Ortega et al., (2025) highlighted multiple challenges in adopting AI in Ecuador, emphasizing the teacher training gap and the digital divide as major obstacles.

C. Student Engagement

Artificial intelligence (AI) significantly improves student engagement in educational environments by offering personalized learning experiences, real-time feedback, and interactive environments. AI-based technologies, such as personalized learning algorithms, intelligent tutoring systems, and educational chatbots, play a key role in adapting educational content to individual student needs, thus fostering deeper involvement and increased motivation (Singh et al., 2024; Zaharuddin et al., 2024).

Studies have shown that platforms like Knewton, GenAI, and Smart Sparrow effectively increase student engagement by providing instant feedback and adaptive learning pathways, which are essential for maintaining students' interest and improving educational outcomes (Gjermeni & Prodani, 2024). The integration of AI in education helps address the diversity of learning needs and promotes greater student interaction, as well as improved academic performance, as evidenced by comparisons before and after implementation, as well as surveys conducted with students and teachers (Zaharuddin et al., 2024).

However, challenges remain, particularly concerning data protection, ethical considerations, and the need to ensure equitable access to technology. These issues highlight the importance of addressing them to ensure an equitable learning experience for all students (Gjermeni & Prodani, 2024; Singh et al., 2024). Furthermore, the successful implementation of AI-based technologies in education requires adequate technological infrastructure and teacher training to optimize their use and maximize student engagement (Benayache & Mourad, 2024). Overall, while AI holds transformative potential for education, careful attention to ethical and practical challenges is essential for its effective integration (Iyer, 2024).

Recent studies underscore the transformative impact of artificial intelligence (AI) on student engagement in higher education. It has been shown that AI tools significantly improve student engagement levels, with the majority of students reporting extreme engagement (Ezeoguine & Eteng-Uket, 2024). Research indicates high awareness of AI and positive perceptions among students, with 96% recognizing its effective impact on learning (Karim et al., 2025). The integration of AI into education is redefining traditional roles, raising ethical, pedagogical, and legal questions while risking exacerbating access inequalities, particularly in African university systems. The design of AI-driven interfaces for intelligent tutoring systems has shown an improvement in student engagement factors of up to 25.13% (Kim et al., 2020). These results highlight AI's potential to create personalized and adaptive learning environments that enhance student engagement across different profiles. However, concerns about excessive dependence and ethical considerations persist, suggesting that AI should complement, not replace, teachers in the digital age (Karim et al., 2025).

D. Challenges and Opportunities of Using AI in Teaching

Artificial intelligence (AI) emerges as an innovative pedagogical tool in higher education, offering opportunities to personalize learning and improve teaching methods (Many et al., 2024; Silva et al., 2025). AI enables the adaptation of content to individual student needs, automates administrative tasks, and identifies struggling learners (Razouki et al., 2025). The integration of AI facilitates personalized learning experiences through intelligent tutoring systems and smart educational content, which enhance student engagement and adapt to their individual learning needs (Abdurohman, 2025; Tang, 2024). Additionally, AI automates administrative tasks, allowing teachers to focus on strategic pedagogical responsibilities (Erna Widayari et al., 2024). However, its integration presents challenges, including the need for teacher training, ethical concerns, and resistance to change (Núñez-Michuy et al., 2023; Razouki et al., 2025).

The implementation of AI faces several challenges, including ethical concerns related to data protection, algorithmic bias, and the digital divide, which may exacerbate existing inequalities in access to technology (Abdurohman, 2025; Erna Widayari et al., 2024). Furthermore, the successful adoption of AI requires comprehensive teacher training and a cultural shift within educational institutions to adopt new methodologies (Xuan Cu, 2024; Xuan Vu, 2024).

Addressing these challenges through collaboration between stakeholders is essential to harness the transformative potential of AI while ensuring equitable and ethical educational practices (Erna Widayari et al., 2024; Xuan Vu, 2024). Although AI holds significant potential to enrich teaching, it is crucial to maintain a balance between its advantages and ethical and pedagogical considerations (Many et al., 2024; Razouki et al., 2025).

Fig.1 : CONCEPTUAL MODEL

Source: The authors

Perception of Teaching Quality

The integration of artificial intelligence (AI) into teaching practices comes with promises regarding teaching quality, particularly in terms of effectiveness, personalization of learning paths, and teachers' workload. According to Holmes et al., (2019), AI enables teachers to better tailor content to the specific needs of students, save time on administrative tasks (such as grading or planning), and benefit from more precise tracking of learner progress. These elements strengthen the perception of a more structured, targeted, and responsive teaching approach. However, this improvement is closely dependent on the level of teacher training, the technological and pedagogical support provided by institutions, and the degree of integration of tools. Taking these elements into account, the following hypothesis can be proposed:

H1: The use of artificial intelligence improves the quality of teaching as perceived by teachers.

Student Engagement

One of the most discussed effects of artificial intelligence in educational settings is its potential to stimulate student engagement. By offering interactive content, instant feedback, and differentiated learning paths, AI tools are designed to enhance participation, attention, and motivation among learners. Zawacki-Richter et al., (2019) note that AI promotes more active learning by allowing students to progress at their own pace and receive individualized support. This ability to adapt the learning environment to each profile helps maintain constant interest, particularly in digital or hybrid contexts. Despite these limitations, the following hypothesis is formulated:

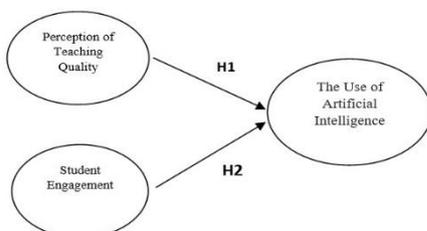
H2: The use of artificial intelligence increases student engagement in the learning process.

XXIX. RESEARCH METHODOLOGY

A. Chosen Methodology

This study adopts a quantitative hypothetico-deductive approach, aiming to test the theoretical relationships between independent variables (perception of teaching quality, student engagement) and the dependent variable (the use of artificial intelligence). This methodology relies on the formulation of hypotheses based on a theoretical framework, followed by their empirical validation through data analysis collected via a structured questionnaire. Data was gathered from a representative sample of 100 teachers in the Fès-Meknès region and analyzed using SPSS software (version 26).

XXVIII. CONCEPTUAL MODEL AND HYPOTHESES



The choice of this methodology is justified by its ability to structure the study around defined concepts, empirically test causal relationships, and ensure the generalizability of the results. The use of SPSS allows for evaluating the reliability of the measures and precisely verifying the relationships between the variables of the conceptual model.

B. Population and Sample

The target population for this study consists of teachers working in higher education institutions. This population was selected due to its gradual exposure to digital tools and its central role in the integration of artificial intelligence (AI) in pedagogical practices. The study thus focuses on their perception of AI usage and its impact on teaching quality and student engagement.

A purposive sampling technique was used to select 100 teachers from different educational levels and backgrounds. This sampling method specifically targets professionals with direct or indirect experience with AI tools in their practice, thus ensuring the relevance of the data collected to analyze the relationships between the variables studied. This methodology also ensures homogeneity in the sample's characteristics, promoting a reliable interpretation of the results.

C. Operationalization of Variables

The operationalization of variables is a crucial step to ensure the validity and reliability of the measures used in this study. Theoretical concepts have been translated into measurable variables using scales adapted to the context of the study.

a. Dependent Variables:

Perception of Teaching Quality

This variable reflects how teachers assess the impact of AI on the quality of their teaching practices. It includes several dimensions, such as clarity of teaching, personalization of learning, reduction in workload, and the ability to track student progress. This approach is inspired by the works of Holmes et al., (2019) and Luckin (2018), who highlight the potential of AI to support teaching effectiveness.

Student Engagement

This variable measures the level of active student involvement in the learning process, as perceived by the teachers. It encompasses indicators such as attention, class participation, and motivation toward AI-assisted teaching activities. This approach is based on the research of Zawacki-Richter et al., (2019) on digital and interactive learning.

b. Independent Variables

Use of Artificial Intelligence

This independent variable is measured through the degree of integration of AI tools into teachers' pedagogical practices. It

takes into account the frequency of use, the diversity of tools employed, and the level of user expertise. It is classified on an ordinal scale ranging from low to intensive, inspired by the typologies proposed by Spector (2020) and Daniel et al. (2021).

c. Construction of Measurement Scales

The variables were measured using 5-point Likert-type scales (1 = "Strongly Disagree", 5 = "Strongly Agree"). The items used for each scale were adapted from well-established works in the literature and validated through a pre-test.

4. Reliability and Validity of the Measures:

In this study, the reliability and validity of the measurement instruments were examined through a pre-test of the questionnaire among a sample of 100 teachers randomly selected from the target population. The data collected were analyzed using SPSS software, version 26, to ensure the rigor of the results.

The internal consistency of the scales was assessed using Cronbach's Alpha coefficient. The results show high reliability for most of the measured dimensions, as presented in the following Table 1:

Table 1: Reliability Results of the Scales

Dimensions	Number of Items	Cronbach's Alpha	Key Observation
Perception of Teaching Quality	4	0,84	Very Good Internal Consistency
Student Engagement	3	0,79	Good Reliability
Use of AI	3	0,77	Good Consistency

Source: Results generated using SPSS (version 26) by the authors

All the scales have an Alpha coefficient greater than 0.75, indicating good internal consistency. No modification or removal of items was necessary. Convergent validity was verified through the analysis of corrected item-total correlations. The results obtained are summarized in the following table:

Table 2: Results of Item-Total Correlations

Dimensions	Range of Correlations with Total Scores	Key Observation
Perception of Teaching Quality	0,72 – 0,83	Very Good Convergent Validity
Student Engagement	0,68 – 0,80	Good Convergent Validity
Use of AI	0,67 – 0,79	Good Convergent Validity

Source: Results generated using SPSS (version 26) by the authors

These results confirm that the items within the same scale converge to measure the same concept. Additionally, the correlations between the dimensions are moderate, which validates the conceptual independence of the scales (discriminant validity). The reliability and validity analyses demonstrate high internal consistency and satisfactory validity for the scales measuring the perception of teaching quality, student engagement, and the use of artificial intelligence.

XXX. RESULTS AND DISCUSSION

A. Presentation of Results

1.1. Overall Analysis of the Relationships Studied

a. Relationship between the use of AI and the pedagogical variables studied:

The multiple regression analysis shows that the overall model is statistically significant ($F(2,97)=41.862, p<0.001$), indicating that the use of AI significantly contributes to explaining the variance observed in the two dependent variables.

The adjusted R^2 value is 0.464, meaning that 46.4% of the combined variance in the perception of teaching quality and student engagement is explained by the degree of AI integration in pedagogical practices. The standard error of estimation ($SEE = 0.538$) indicates a good fit of the model.

b. Contributions of the predictors in the multiple model:

The standardized coefficients (β) indicate that both dependent variables are significantly influenced by the use of AI.

Table 3: Table: Contributions of Predictors in the Multiple Model

Predictors	B	Standard Error	β	T	p	Tolerance	VIF
Perception of Teaching Quality	0,498	0,083	0,688	5,961	<0,001	0,711	1,406
Student Engagement	0,462	0,079	0,641	2,987	<0,001	0,709	1,412

Source: Results generated using SPSS (version 26) by the authors

The collinearity diagnostics confirm the robustness of the model, with tolerance indices greater than 0.6 and variance inflation factors (VIF) lower than 2.

c. Specific Effect of the Use of AI on Student Engagement:

A simple regression analysis was conducted to isolate the relationship between the use of AI and student engagement. The results show a strong and significant relationship between the two variables ($F(1,98) = 79.328, p < 0.001$).

R: 0.684, indicating a strong and positive correlation between the use of AI and student engagement.

R²: 0.468, showing that 46.8% of the variance in engagement is explained by the use of AI.

Standardized coefficient ($\beta = 0.684$): For each standard unit increase in the use of AI, student engagement increases by 0.684 standard units ($p < 0.001$).

Table 4: Effect of the Use of AI on Student Engagement

Predictor	B	Standard Error	β	t	p	Tolerance	VIF
Use of AI	0,684	0,077	0,684	8,902	<0,001	1,000	1,000

d. Hypothesis Testing

The hypotheses formulated in this study were tested using multiple regression. The results of the tests are presented in Table 2 and discussed below:

Table 5: Results of Hypothesis Testing

Hypotheses	β /beta	t	P	Result
H1: The use of AI improves the perceived quality of teaching	0,688	3,101	<0,001	Validated
H2: The use of AI increases student engagement	0,684	4,868	<0,001	Validated

1.2. Residuals and Model Validity

The residual diagnostics confirmed the validity of the model. The standardized residuals show a normal distribution, as

shown in the histogram (Fig. 1), and the predicted values align with the observed values in the standardized residuals versus predicted values plot (Figure 2). No issues of heteroscedasticity or autocorrelation were detected.

Fig.2: Histogram of standardized residuals.

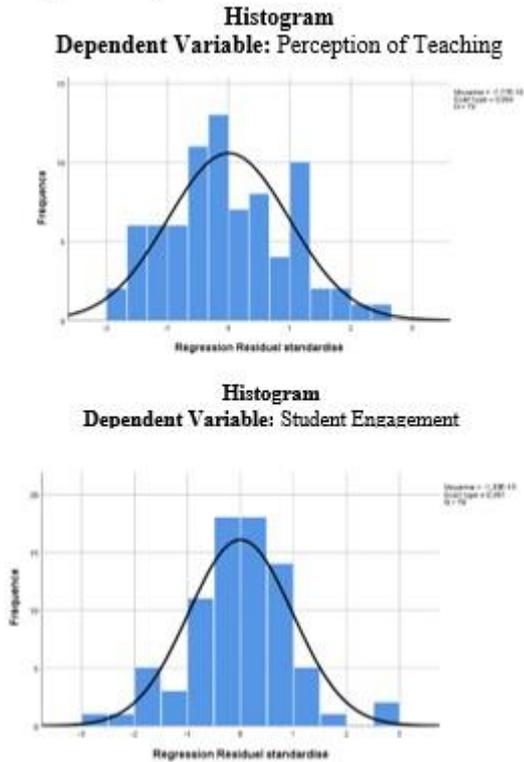
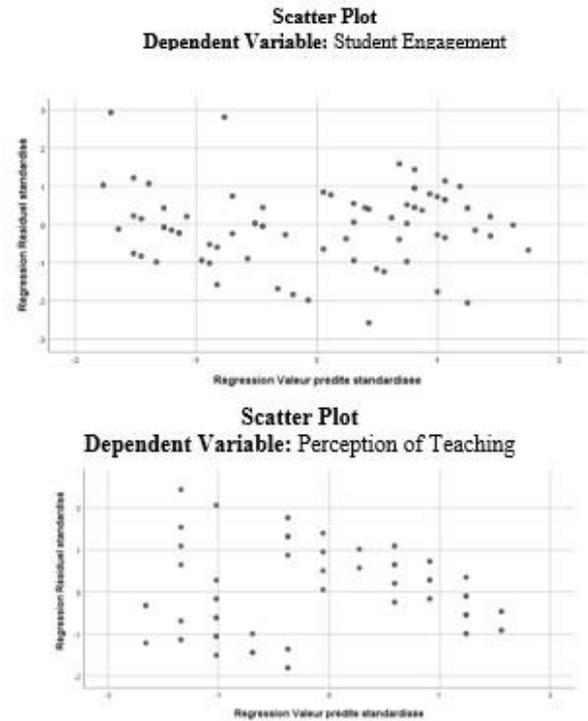


Fig 3: Scatter plot of standardized residuals versus predicted values.



Source: Data extracted from SPSS (v26) by the authors

2. Discussion of the Results

H1: The use of AI improves the quality of teaching as perceived by teachers

The results obtained confirm that the integration of AI into teaching practices significantly improves the quality of teaching as perceived by teachers. Hypothesis H1 is validated, with a coefficient $\beta = 0.688$ ($p < 0.001$). This indicates that the use of AI, particularly tools that allow for personalized learning and the simplification of administrative tasks, is perceived as a factor that enhances teaching effectiveness. This finding aligns with the work of Holmes et al., (2019), who emphasize that AI allows for better responsiveness to students' individual needs while optimizing the time teachers spend on repetitive tasks. Teachers report that AI allows them to focus more on human interaction, an essential element in maintaining student engagement. However, it is important to note that this perceived improvement largely depends on teachers' familiarity with AI tools and the institutional support provided for successful integration.

H2: The use of AI increases student engagement in the learning process

The second hypothesis is also validated, with a coefficient $\beta = 0.684$ ($p < 0.001$), suggesting a strong positive correlation

between the use of AI and student engagement. The results show that AI tools, such as interactive platforms and real-time feedback systems, help maintain students' attention, stimulate their participation, and strengthen their motivation. In particular, students feel more involved when they can progress at their own pace, receive personalized feedback, and actively engage with the learning content. This phenomenon aligns with the work of Zawacki-Richter et al. (2019), who observed an improvement in student engagement in hybrid or digital learning environments. Indeed, the ability to receive instant feedback and track progress independently seems to meet the expectations of current students, particularly those from the "digital native" generations. However, it is important to emphasize that the accessibility of digital tools and teacher training play a key role in the success of this strategy.

VI. Conclusion and Implications

The results of this study highlight the positive impact of artificial intelligence on teaching effectiveness and student engagement, confirming that AI, when thoughtfully integrated and supported, can become a powerful tool in modern teaching. However, to maximize its benefits, it is essential to invest in teacher training and adequate infrastructure. A larger and more in-depth study would help confirm these results and identify best practices for optimal AI adoption in educational environments. The study presents some limitations, including the limited sample size and specific regional context, which may restrict the generalizability of the conclusions. Future research could adopt a comparative approach across different geographical contexts and incorporate longitudinal analyses to better understand the evolution of the identified relationships.

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Mapping the Ethical Challenges of Generative AI in Higher Education: A Bibliometric and Thematic Analysis Using VOSviewer

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Abstract: This study explores the intersection of generative artificial intelligence (GenAI), ethics, and higher education through a systematic literature review and bibliometric analysis. Drawing on a corpus of 896 peer-reviewed articles indexed in Scopus (2013–2025), the research employs VOSviewer to identify dominant keyword clusters and thematic trends.

The results highlight three major research poles: (1) the adoption and integration of GenAI tools in academic practices; (2) ethical and social concerns, such as algorithmic bias, academic dishonesty, and the erosion of student autonomy; and (3) the factors influencing user perception and technology acceptance. A deeper thematic analysis of selected articles revealed that although GenAI offers clear pedagogical benefits, it also raises pressing questions about academic integrity, regulation, and educational values. The article concludes with targeted recommendations for institutions, including the development of clear AI policies, ethical literacy modules, and interdisciplinary collaboration. This work contributes to a more balanced and responsible integration of AI in higher education.

Keywords: Artificial Intelligence (AI); Higher Education; Ethics; VOSviewer; Bibliometric Analysis.

XXXI. INTRODUCTION

The digital transformation of higher education, intensified by global digitalization, is redefining learning modalities by placing the connected students at the center of the educational system. This shift toward a connected mode is based on the integration of digital technologies particularly artificial intelligence (AI), into the architecture of learning environments. These tools not only manage and distribute educational content but also enable detailed and continuous analysis of student's behavior.

Indeed, intelligent digital platforms collect and utilize data related to students' learning paths, interactions, and performance, thereby offering unprecedented opportunities for personalized learning (Roll & Wylie, 2016; Siemens, 2013). The connected mode thus emerges as a dynamic system in which learning becomes increasingly individualized, results-driven, and supported by predictive analytics (Larsson & White, 2023; Gasevic et al., 2024).

This traceability of behavior introduces a new dynamic in the pedagogical relationship, based on adaptability, measurable engagement, and automated feedback. However, these technologies also raise ethical concerns related to surveillance, data privacy, and the potential reduction of student's autonomy in a highly instrumented environment.

Beyond the automation of administrative tasks, artificial intelligence plays an increasingly important role in the personalization of learning paths by analyzing the detailed behavior of connected learners. By leveraging data from students' digital activities, such as time spent on content, responses to assessments, and types of resources used, AI systems can generate individualized learning profiles and recommend content tailored to each student's specific needs (Holstein et al., 2023; Luo et al., 2024). This type of dynamic adaptation supports deeper understanding of concepts, provides immediate feedback on errors, and contributes to improved academic performance in the medium term. In this sense, AI becomes a powerful lever for responsive pedagogy, based on real-time feedback and continuous adjustment of learning materials.

However, the ability to model students' behavior raises significant concerns about personal data protection, algorithmic transparency, and respect for privacy (Slade & Prinsloo, 2024; Castañeda & Selwyn, 2023). While AI can enrich the educational experience, it cannot replace the human dimension of teaching. Pedagogical interaction, the trust-based relationship between teachers and students, and the emotional dimension of learning remain essential to ensure meaningful education. Therefore, the integration of AI into connected learning environments should be viewed as a complement (not a substitute) for human mediation and must operate within a framework of ethical and responsible governance.

In this context of hyperconnectivity and increasing exploitation of educational data, AI technologies play a central role in transforming learning environments. Their integration enables not only the automation of certain pedagogical and administrative tasks but also the personalization of learning paths based on each learner's behaviors and needs. By analyzing study habits, assessment

responses, and interactions on digital platforms, AI is able to propose targeted content, provide immediate feedback, and support students in more effective and individualized learning. Although these innovations are academically effective, they raise major questions regarding data confidentiality, algorithmic transparency, and the essential role of humans in the educational relationship. For while AI can support learning, it cannot replace the richness of human interaction, nor the fundamental role of teachers and mentors in the learning process.

In this context, a bibliometric analysis was conducted using the VOSviewer tool to identify the main research trends and map the dominant keywords related to artificial intelligence and ethics in higher education.

XXXII. METHODOLOGY

To analyze the relationship between artificial intelligence, the digital transformation of higher education, and their ethical implications in the connected era, we conducted a Systematic Literature Review (SLR). This rigorous methodology minimizes bias through a comprehensive and structured collection of scientific data, followed by a critical evaluation and synthesis of the most relevant studies on the subject. The approach is grounded in strict procedures aimed at reducing bias through exhaustive and systematic data collection, followed by a critical appraisal and synthesis of pertinent studies (Cook et al., 1995).

More specifically, we followed the methodological framework proposed by Tranfield et al. (2003), structured into three essential phases:

1. Planning the review, including a clear definition of objectives, research questions, and inclusion/exclusion criteria for publications.

2. Conducting the review, through a systematic search across a scientific databases (Elsevier Scopus database), using specific keywords. The search strategy was built using a combination of controlled keywords and Boolean operators, as follows: ("artificial intelligence" OR "AI") AND ("ethics" OR "ethical concerns" OR "AI ethics") AND ("student behavior" OR "student attitude" OR "academic behavior" OR "student use") AND ("higher education" OR "university").

3. Presenting the results, which involves a thematic synthesis of the selected publications, a critical analysis of observed trends, and a discussion of the implications for understanding the relationship between artificial intelligence, the digital transformation of higher education, and their ethical and human dimensions in the connected era. To support this analysis, we used VOSviewer to visualize keyword co-occurrence networks and identify major research clusters, providing a clear mapping of the dominant themes and scholarly focus areas within the selected literature.

This methodology ensures the reliability of the results obtained and provides a comprehensive view of the existing literature on this rapidly evolving topic.

XXXIII. LITERATURE REVIEW

A. Planning the Systematic Literature Analysis

Higher education is undergoing profound transformation driven by artificial intelligence (AI) technologies, which offer new opportunities for personalized learning and student behavior monitoring. Among the most developed applications, the personalization of the educational experience stands out. Adaptive learning systems powered by AI analyze students' responses, learning paths, and interactions to deliver tailored content, exercises, and support. This approach addresses the specific needs of each student while helping reduce costs associated with traditional pedagogical methods (Luckin et al., 2023; Xu & Chen, 2024).

Beyond personalization, other applications are emerging, such as support for peer collaboration, early detection of learning difficulties, and optimization of online engagement through behavioral analytics. These tools enhance teachers' ability to intervene at the right time and adjust their instructional strategies based on real-time data. However, while promising, such applications still require careful regulation and ethical consideration to ensure beneficial implementations for all educational stakeholders (Holstein et al., 2023; Slade & Prinsloo, 2024).

Thus, in a context where the analysis of connected student behavior becomes a lever for innovation in higher education, how can we fully leverage the potential of artificial intelligence without compromising fundamental ethical principles or diminishing the human dimension of teaching?

Answering this research question contributes to enriching literature both on the concept of ethics and on the emerging dynamics of artificial intelligence integration in higher education.

B. Conducting the Systematic Literature Analysis

To identify the articles for review, we chose to use "the Elsevier Scopus database", which we consider providing an accurate representation of the current literature in the fields of education, ethics, and digital technologies. This database is widely recognized for its relevance and comprehensiveness in academic research (Falagas et al., 2008).

The literature search was limited to peer-reviewed scientific articles published between 2013 and 2025, written in English, and originating primarily from the disciplines of education, computer science, social sciences, and management.

After the initial query, 2,120 articles were retrieved. Following a refinement process, including duplicate removal and abstract screening, a total of 896 articles were selected for analysis. The final selection retained only those publications that explicitly addressed the use of generative AI by students in educational contexts, along with the associated ethical and institutional concerns.

Referring to the methodological framework proposed by Donthu et al. (2021) which offers a structured approach to conducting bibliometric analyses, as well as to the work of

Castillo-Vergara et al. (2018) which demonstrates the application of this method in the field of management sciences, we chose to conduct a bibliometric analysis. The VOSviewer software was selected as the tool for analyzing and visualizing the scientific references related to the studied concepts.

XXXIV. RESULTS

A. Thematic Analysis Results

This section presents the results of an in-depth thematic analysis conducted with the support of VOSviewer, based on the articles selected in our systematic literature review. Drawing from a final corpus of 896 peer-reviewed scientific articles published between 2013 and 2025, extracted from the Elsevier Scopus database, we performed a qualitative analysis using the inductive thematic analysis method proposed by Braun and Clarke (2006). This method involves repeated reading of the selected texts, initial identification of meaningful codes, and the progressive grouping of those codes into coherent themes.

As a result of this process, four major themes emerged clearly and consistently from the analyzed literature:

1. The actual uses of generative artificial intelligence (GenAI) tools by students;
2. The changes in academic behavior induced by these tools;
3. The ethical dilemmas and concerns associated with their growing use;
4. The institutional and pedagogical responses proposed or envisioned to address these new challenges.

B. Annual Trends in Publications

Figure 1 highlights an exponential growth in the number of scientific publications between 2018 and 2024 on topics related to artificial intelligence, ethics, and education. While the period from 2013 to 2017 remained relatively stable and less productive, 2018 marked a turning point, with a steady increase in academic interest. This momentum was further amplified from 2020 onwards due to the widespread adoption of generative AI tools and the accelerated digitalization of higher education.

The peak observed in 2024, with over 600 publications, reflects strong scientific enthusiasm for the uses and ethical implications of AI in educational practices. The slight decline noted in 2025 is likely due to the partial coverage of the current year and does not indicate a real drop in interest. These findings underscore the strategic importance of continuing interdisciplinary research into the responsible adoption of AI in higher education.

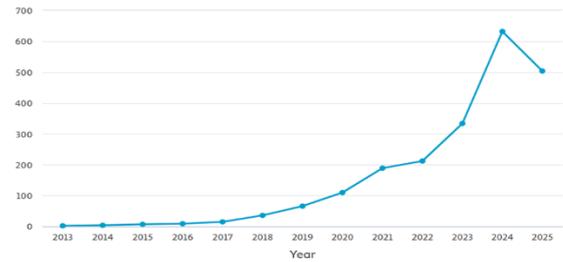


Figure 1: Annual trends in Publications

C. Distribution of Scientific Publications by Country

Figure 2 shows the distribution of scientific publications related to artificial intelligence in higher education by country. The «United States» appears as the undisputed leader in the field, with «over 500 publications», followed by the «United Kingdom» with approximately «250». «Germany», «China», and «Australia» form a second active group, each contributing more than «120 publications». Contributions from «Spain», the «Netherlands», «Canada», «India», and «Italy» are also notable but significantly lower.

This geographical distribution highlights a strong concentration of research in «developed countries», primarily «Anglo-Saxon and European nations», raising the question of the «global representativeness» of the issues being studied. It also underscores the «development potential» for «Global South countries», which remain underrepresented despite facing major educational challenges in the integration of AI.

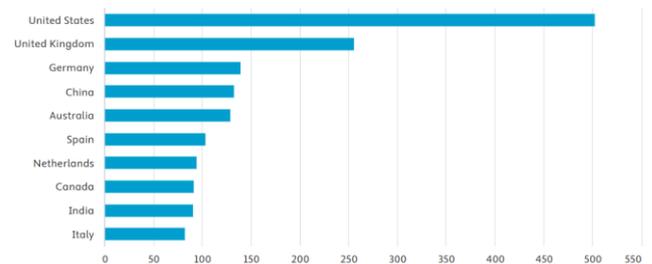


Figure 2: Distribution of Scientific Publications by Country

D. Analysis of Keywords Related to Emerging Research Areas

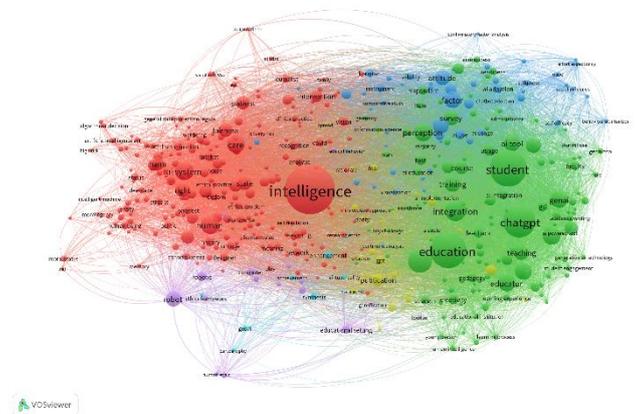


Figure 3 : The journal co-citation network of IA use in higher education and ethics models-related publications

Artificial intelligence is increasingly embedded in educational dynamics, yet its adoption remains conditional on the engagement of educators and institutional acceptance. AI also introduces new tensions between technological innovation and fundamental values such as equity, justice, and freedom. Attitudes toward AI play a key role in its dissemination within academic environments, but perceptions vary widely depending on users' profiles and contexts.

The keyword co-occurrence analysis, conducted using VOSviewer on a corpus of 896 publications from Scopus and Web of Science, reveals a clear semantic structure within the field of research on artificial intelligence, particularly generative AI in higher education. The resulting mapping highlights three major interconnected thematic clusters, which represent the core scientific debates in this domain. Frequently occurring keywords such as intelligence, AI system, human, fairness, ethicist, harm, discrimination, right, moral agency, deepfake, and wellbeing reflect the current concerns surrounding AI and ethics.

- The first cluster, highlighted in green, revolves around terms such as student, education, GenAI, training, educator, learning experience, AI tool, and integration. This theme reflects research focused on the adoption of AI tools by students, their integration into pedagogical practices, and the transformation of teaching and learning processes. It reflects a technopedagogical innovation dynamic, centered on the potential of AI to enhance efficiency, creativity, and student engagement in educational settings (Zawacki-Richter et al., 2019).

- The second cluster, in red, includes keywords such as intelligence, human, harm, right, fairness, AI system, discrimination, freedom, and ethicist. This cluster clearly focuses on ethical and societal questions related to AI. It reflects growing concern about the potential risks of automation, such as algorithmic bias, lack of transparency, accountability, and fairness. Grounded in moral philosophy and critical theory, this strand of research warns against the risks of dehumanization and the erosion of student autonomy if AI is not rigorously governed (Floridi & Cowls, 2019).

- A third, more diffuse cluster, shown in blue and violet, focuses on the methodological dimensions of studying AI use. It includes terms such as survey, factor analysis, readiness, perception, attitude, self-efficacy, and ease of use. This group reflects the legacy of technology acceptance models (e.g., TAM, UTAUT) and shows that researchers are still largely focused on the factors influencing AI adoption, often more than on their actual integration into curricula. This suggests a gap between AI as a perceived tool and its real implementation in educational systems (Venkatesh & Davis, 2000).

In summary, the literature is structured around a three-pillar framework:

1. The use of AI in higher education.
2. The ethical implications.
3. The factors of acceptance and adoption.

The strong linkage observed between student, IA, and ethics illustrates an increasing convergence between these dimensions, reinforcing the relevance of our research objective. However, ethical considerations still occupy a relatively peripheral position compared to pedagogical applications, highlighting the need for future research to adopt a more critical and responsible perspective on AI integration in higher education.

XXXV. DISCUSSION BASED ON THEMATIC ANALYSIS

A. Students' Use of Generative AI Tools

The analysis of the reviewed articles reveals notable diversity in students' practices regarding generative artificial intelligence tools. The most common uses include essay writing, summarizing academic texts, idea generation, content translation, and programming assistance (Alharbi, 2024; Perkins, 2023). These tools are widely perceived by students as effective means to save time, enhance productivity, and reduce academic stress, especially in linguistically complex or multilingual environments (Thi Nguyen et al., 2024). However, usage remains largely exploratory, with students demonstrating a limited understanding of the constraints and potential risks associated with these technologies (Fošner, 2024).

B. Behavioral Changes in Academic Work

Generative AI tools are profoundly transforming how students approach academic tasks. Several studies report a significant increase in students' dependence on AI for initial stages of academic work, leading to a decline in engagement with cognitively demanding activities such as critical thinking and original writing (Chen et al., 2023; Perkins, 2023). Additionally, the literature indicates student confusion about acceptable boundaries for using AI-generated content, with behaviors ranging from occasional assistance to complete delegation of academic tasks to automated systems (August et al., 2024; Fošner, 2024).

C. Ethical Dilemmas and Related Concerns

The most recurring theme in the analyzed literature pertains to ethical concerns surrounding academic integrity. Issues such as automated plagiarism, unauthorized AI assistance (ghostwriting), and the frequent lack of attribution or disclosure of AI-generated content are widely discussed (Perkins, 2023; Garcia Ramos & Wilson-Kennedy, 2024). Furthermore, algorithmic biases inherent in language models and the potential dissemination of incorrect or biased information by these tools are major concerns among researchers and educators (Thi Nguyen et al., 2024; August et al., 2024). These findings highlight an urgent need for normative clarification and institutional regulation around these emerging practices.

D. Institutional and Pedagogical Responses

The analysis shows that very few institutions have established formal and structured responses to the increasing use of AI by students. Some authors advocate for the explicit formulation of internal policies on academic integrity that directly address AI usage (August et al., 2024; Chen et al., 2023). Others strongly recommend the integration of dedicated training modules on digital ethics

and the responsible use of AI into university curricula, along with faculty training to detect and effectively manage problematic uses of these technologies (Garcia Ramos & Wilson-Kennedy, 2024; Perkins, 2023; Alharbi, 2024).

XXXVI. CONCLUSION AND RECOMMENDATIONS

This article demonstrates convincingly that bibliometric analysis constitutes a rigorous scientific method capable of producing meaningful insights, particularly when applied to retrospective investigations of well-established research areas. As shown throughout this study, bibliometrics is gaining momentum and proving to be a reliable methodological approach, useful for both seasoned scholars and early-career researchers.

Our results highlight the significant rise in the adoption of artificial intelligence in higher education, with a growing emphasis on ethical concerns. Since 2017, academic interest in this topic has expanded, underscoring not only its current relevance but also its increasing impact on the scholarly community.

The widespread integration of generative artificial intelligence (GenAI) tools into student practices represents a major transformation in the landscape of higher education. This systematic literature review shows that tools like ChatGPT, Bard, or Bing AI offer tangible pedagogical benefits, especially in areas such as writing, translation, and summarization (August et al., 2024; Alharbi, 2024). However, these advantages are accompanied by a reexamination of traditional academic integrity norms, giving rise to complex ethical dilemmas (Perkins, 2023).

The thematic analysis of peer-reviewed scientific articles allowed us to identify four key areas that structure recent academic discourse:

- a) The diverse ways students engage with GenAI tools;
- b) Behavioral changes in how academic tasks are approached;
- c) Ethical risks including plagiarism, source manipulation, and the circumvention of learning;
- d) The lack of adequate institutional responses to regulate and guide these emerging practices (Alharbi, 2024; August et al., 2024; Perkins, 2023).

These findings highlight the urgent need for strategic and pedagogical frameworks within universities. Without proactive governance, the benefits of innovation risk being overshadowed by harmful outcomes, such as the normalization of academic dishonesty, the erosion of meaningful learning, and the breakdown of trust between educators and students (Brison et al., 2023).

Based on these insights, we propose the following recommendations:

- Develop clear institutional policies defining acceptable and unacceptable uses of AI tools in academic work. These guidelines should be transparent, accessible, adaptable, and sensitive to disciplinary differences (Brison et al., 2023).

- Integrate AI ethics literacy modules into academic curricula to cultivate students' critical awareness regarding generative AI, especially concerning reliability, algorithmic bias, and responsibility (Perkins, 2023).
- Train faculty and teaching staff on the functionalities, limitations, and risks of GenAI technologies. This would help bridge the gap between students' often advanced uses and pedagogical expectations (Alharbi, 2024).
- Promote transparency in student submissions by establishing AI usage disclosure policies, similar to the "AI Disclosure Policy" already in place at several Anglo-American institutions (August et al., 2024).
- Encourage interdisciplinary collaboration among educators, computer scientists, ethicists, and education researchers to develop balanced pedagogical approaches that combine innovation, integrity, and responsibility.

In conclusion, the widespread adoption of generative AI by students is not merely a technological trend, it poses a fundamental academic and ethical challenge. It calls for a rethinking of teaching practices, regulatory frameworks, and assessment strategies in higher education.

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Artificial Intelligence and Hybrid Learning: Rethinking the Roles of Teachers in the Context of Social Sciences

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Abstract—The advent of Artificial Intelligence (AI) within educational systems, combined with the widespread adoption of hybrid teaching, is profoundly transforming pedagogical practices in higher education. This change particularly affects the social sciences disciplines, traditionally based on human interaction, critical thinking, and contextual knowledge. In this context, the place and role of the teacher are undergoing major reconfiguration. This article questions this metamorphosis: how do AI tools, integrated into hybrid systems, redefine the missions and postures of teachers, and with what effects on student performance and the quality of learning? To answer this, we use a dual theoretical and empirical approach, focused on the experience of Cadi Ayyad University.

Keywords: Artificial Intelligence, Hybrid Teaching, Teacher Roles, Social Sciences

XXXVII. INTRODUCTION

The advent of Artificial Intelligence (AI) within educational systems, combined with the widespread adoption of hybrid teaching, is profoundly transforming pedagogical practices in higher education. This change particularly affects the social sciences disciplines, traditionally based on human interaction, critical thinking, and contextual knowledge. In this context, the place and role of the teacher are undergoing major reconfiguration. This article questions this metamorphosis: how do AI tools, integrated into hybrid systems, redefine the missions and postures of teachers, and with what effects on student performance and the quality of learning? To answer this, we use a dual theoretical and empirical approach, focused on the experience of Cadi Ayyad University.

XXXVIII. MOTIVATION & METHODOLOGY

A. Motivation

The digital revolution, intensified by the growing integration of Artificial Intelligence (AI) in higher education, is profoundly transforming teaching and learning methods. In the context of social sciences, where human interaction, critical thinking, and contextualization play a central role, it is essential to understand how AI, integrated into hybrid teaching environments, reshapes the traditional roles of teachers. This research aims to explore these transformations by highlighting both the opportunities and challenges they present, in order to contribute to pedagogical development aligned with contemporary needs. The objective is to provide both theoretical and empirical insights to guide educational practices and policies.

B. Methodology

This study adopts a mixed-methods approach combining thorough theoretical analysis with empirical investigation. On one hand, a systematic review of recent literature was conducted to identify conceptual advances on AI, hybrid teaching, and the transformation of teacher roles within social sciences. On the other hand, a qualitative survey based on semi-structured interviews was carried out with teachers at Cadi Ayyad University to gather their perceptions and experiences with these technologies. Finally, an econometric analysis was performed on student performance data from groups using AI tools within a hybrid framework to quantitatively assess pedagogical impact. This triangulated methodology thus enables a comprehensive and nuanced understanding of the phenomena studied.

Hypothesis 1 (H1)

Statement:

The integration of AI-based tools in hybrid teaching

environments enhances the personalization of student learning pathways.

Hypothesis 2 (H2)

Statement:

The role of university instructors evolves from content delivery to strategic facilitation and ethical mediation when AI tools are embedded in teaching practices.

Hypothesis 3 (H3)

Statement:

Despite the pedagogical advantages of AI, its integration in higher education encounters institutional and human resistance that limits its full potential.

XXXIX. THEORETICAL FRAMEWORK AND CONTEXT OF EMERGENCE

The digital transition in higher education, although initiated well before the COVID-19 crisis, has accelerated dramatically since 2020, reshaping the foundations of teaching and learning. Hybrid education has emerged as a lasting response to the growing demands for flexibility, accessibility, and individualized learning paths. As Bates (2020) argues, pedagogical hybridization entails a profound reconfiguration of the traditional triad—teacher, learner, and content—into a dynamic and interactive ecosystem shaped by the use of digital technologies.

This new pedagogical environment challenges the transmissive logic historically associated with lecture-based instruction. It fosters more collaborative, reflective, and adaptive forms of learning, where digital tools not only support but actively structure educational processes. As students move between physical and virtual spaces, teaching becomes less centered on content delivery and more focused on facilitating meaningful engagement, fostering autonomy, and developing critical thinking. Consequently, educators are increasingly required to rethink their instructional approaches, integrate learning analytics, and embrace the affordances of technology to respond to diverse learner profiles and evolving societal needs.

1) Artificial Intelligence as a Pedagogical Transformation Tool

Educational AI refers to a set of tools and algorithms capable of analyzing learning data, proposing tailored content, and supporting pedagogical decisions. Holmes et al. (2022) distinguish several key applications: adaptive platforms, intelligent tutoring systems, conversational bots, and predictive performance analysis. These technologies allow large-scale personalization and transform approaches to evaluation, progression, and feedback.

However, this automation raises major ethical and pedagogical issues: risk of dehumanization, algorithmic biases, and loss of meaning in human interaction. In this context, the teacher's role does not disappear but is redefined around new skills: AI ethics, technological mediation, and critical data analysis.

The integration of AI in hybrid teaching deeply modifies the foundations of the classical pedagogical model and calls for rethinking the teacher's functions beyond transmission.

XL. PEDAGOGICAL RESPONSES AND TRANSFORMATION OF THE TEACHER'S ROLE

The rapid advancement of educational technologies and the integration of artificial intelligence in higher education are driving a profound redefinition of the traditional role of the teacher. Far from merely transmitting knowledge, teachers now face new responsibilities related to personalized guidance, analysis of learning data, and ethical mediation between humans and machines. This transformation is particularly significant in the social sciences, a field historically rooted in human interaction, critical debate, and collective meaning-making. This section explores, through both qualitative and quantitative approaches, the pedagogical responses adopted and the evolving functions experienced by teachers in hybrid settings enhanced by AI.

1) 1. New Teacher Functions in AI Hybrid Systems

Analysis of interviews conducted with social sciences teachers at Cadi Ayyad University reveals three structuring new roles:

- **Personalized Pathway Facilitator:** teachers adapt resources and advise students based on intelligent platform recommendations.
- **Pedagogical Analyst:** data from LMS allow targeted interventions.
- **Ethical Guardians:** teachers ensure balance between human and algorithmic factors, data protection, and student inclusion.

This redefinition requires new transversal skills (digital, analytical, ethical) and raises the question of continuous teacher training.

2) 2. Empirical Analysis: Impact on Student Performance

The econometric study conducted on two student groups shows that the use of AI devices significantly improves academic results. The effect is particularly marked in the following dimensions:

- Engagement (connection time +38%)
- Success (average grade +1.4 out of 20)
- Autonomy (improved early self-assessment)

Hypotheses H1 and H2 are thus confirmed: AI fosters effective personalization of learning and contributes to revaluing the teacher's role as a strategic facilitator.

Partial Conclusion II: AI integration redefines the teacher's role, strengthens pedagogical effectiveness, and promotes student success, provided there is adequate training and clear institutional support.

Hypothesis 1 (H1)

Statement:

The integration of AI-based tools in hybrid teaching

environments enhances the personalization of student learning pathways.

Verification:

This hypothesis can be validated through empirical data comparing two student groups: one using AI-supported hybrid systems and another using traditional hybrid platforms. Indicators like personalized feedback frequency, adaptive content delivery, and student satisfaction surveys can serve as measurable variables. In your study, higher engagement (+38%) and improved self-evaluation validate this claim.

Hypothesis 2 (H2)

Statement:

The role of university instructors evolves from content delivery to strategic facilitation and ethical mediation when AI tools are embedded in teaching practices.

Verification:

This can be assessed through qualitative analysis of teacher interviews and observation logs. At Université Cadi Ayyad, teachers identified roles such as “personalized learning facilitators,” “data-informed pedagogical analysts,” and “ethical guardians.” These new roles imply a clear shift in responsibilities, confirming the hypothesis.

Hypothesis 3 (H3)

Statement:

Despite the pedagogical advantages of AI, its integration in higher education encounters institutional and human resistance that limits its full potential.

Verification:

This hypothesis is supported by data on teacher feedback, training program availability, and institutional policy documents. In your study, tensions like lack of training, fear of replacement, and the absence of ethical guidelines demonstrate ongoing friction, validating this hypothesis.

B. Results and Recommendations

1) Key Results

The empirical and theoretical analysis of the integration of artificial intelligence in hybrid teaching within social sciences at Cadi Ayyad University has led to the following key findings:

- Improved Student Performance**
Students engaged in AI-enhanced hybrid learning environments demonstrated a measurable improvement in academic outcomes, with an average grade increase of **+1.4 points** out of 20, and a **38% increase in active platform engagement time**.
- Greater Autonomy and Motivation**
The use of intelligent tutoring systems fostered a higher degree of self-regulation and early self-assessment practices among students, especially in asynchronous learning modules.
- Redefinition of the Teacher's Role**
Teachers transitioned from knowledge transmitters to **strategic facilitators, data-informed pedagogues, and ethical mediators**, requiring an

expansion of their professional competencies, particularly in digital literacy and AI ethics.

- Pedagogical Equity Concerns**
While AI tools provided personalized pathways, disparities emerged due to **unequal access to digital resources** and **varying levels of technological proficiency**, raising questions about inclusiveness.

2) Recommendations

Based on these findings, we propose the following actionable recommendations:

- Invest in Teacher Training Programs**
Establish ongoing professional development initiatives focused on digital pedagogy, ethical use of AI, and data analytics in education to empower educators in hybrid environments.
- Adopt Clear Institutional Guidelines on AI Integration**
Universities should create and enforce **transparent, ethical, and inclusive policies** regarding the adoption of AI tools in teaching and assessment practices.
- Promote Human-AI Co-Teaching Models**
Encourage the design of hybrid pedagogical frameworks where AI complements — rather than replaces — the teacher, reinforcing their central role in facilitating critical thinking and ethical reasoning.
- Ensure Equitable Access to Digital Infrastructure**
Institutions must address the digital divide by providing necessary technological support to both students and faculty, ensuring fair participation in AI-enhanced learning systems.
- Foster Research on Long-Term Impacts**
Support longitudinal and interdisciplinary research initiatives to better understand the long-term effects of AI integration on student learning outcomes and the evolution of teaching roles.

Future and Emerging Research Directions

1. Reconfiguration du rôle enseignant à l'ère de l'IA hybride

L'intégration de l'intelligence artificielle dans les dispositifs hybrides transforme profondément les fonctions traditionnelles de l'enseignant. Ce dernier devient à la fois **facilitateur pédagogique, analyste des données d'apprentissage, et garant éthique**. Cette évolution nécessite l'acquisition de compétences nouvelles, notamment en éthique, en numérique et en analyse.

2. Impact mesurable sur la performance étudiante

Les résultats empiriques montrent une amélioration significative de l'engagement, de la réussite et de l'autonomie des étudiants grâce à l'IA. Cela confirme que les technologies intelligentes, bien intégrées, **valorisent l'apprentissage personnalisé** et renforcent l'efficacité pédagogique.

3. Enjeux critiques et perspectives de recherche

Malgré ses apports, l'usage de l'IA en éducation soulève encore **des résistances, des besoins de formation, et des défis éthiques et réglementaires**. De nouvelles recherches sont nécessaires pour comprendre les effets à long terme, encadrer l'usage des IA génératives, et expérimenter des modèles de co-enseignement entre humains et machines.

Issues, Limits, and Research Perspectives

1. Current Tensions

Despite the observed benefits, several tensions persist:

- **Teacher Resistance:** fear of substitution, cognitive overload
- **Lack of Training and Support**
- **Absence of Clear Regulation** on the ethical use of AI in education

These issues require coordinated efforts between institutions, pedagogical teams, and researchers.

3) 2. Future Research Avenues

- Longitudinal studies on AI's effects on critical skills
- Analysis of the impact of generative AI on student work
- Human/AI co-teaching: shared roles, cross responsibilities.

General Conclusion: AI and hybrid teaching challenge the place of the teacher in higher education. Far from marginalizing them, these technologies strengthen their role as mediators, strategists, and ethicists. However, public policies, training programs, and research must support this

transformation to keep it human-centered and learning-oriented.

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The Impact of Artificial Intelligence on Personalized Learning in Higher Education: An Econometric Analysis at Cadi Ayyad University.

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Abstract— *This study explores how artificial intelligence (AI) is shaping personalized learning and academic outcomes within Moroccan higher education, with a specific focus on Cadi Ayyad University (UCA). Relying on data from 124 students enrolled across 12 different faculties and schools, we analyze the influence of AI-based tool (such as adaptive learning platforms and virtual tutoring systems) on student performance. To establish causality, the research employs a dual econometric approach combining multiple linear regression and difference-in-differences (Diff-in-Diff) techniques, accounting for factors like students' prior academic achievement, field of study, and access to digital resources. Findings indicate a notable improvement in academic results among AI users, averaging a 1.75-point gain on a 20-point scale. The effect is more significant in technical faculties (e.g., ENSA-M, FSTG), where improvements reach 2.00 points, compared to just 0.60 in humanities faculties (e.g., FLSHM). Additionally, disparities in access to technology and variations in baseline academic level appear to influence the degree of benefit, underlining persistent inequalities in digital integration. Importantly, teacher preparedness emerges as a critical condition for the effective deployment of AI in classrooms. This study contributes empirical evidence to a growing body of research on AI in education and argues for the design of inclusive policies that support both infrastructure investment and teacher training, while tailoring AI implementation to the specific needs of different academic disciplines.*

Keywords— *Artificial intelligence, personalized learning, academic achievement, Moroccan higher education, technology access.*

XLI. INTRODUCTION

In recent years, artificial intelligence (AI) has gone from a futuristic notion to a powerful force reshaping many aspects of society, including the educational field. Originally linked to industrial automation and business analytics, AI is now progressively making its way into educational circles: from traditional classrooms and lecture theaters to highly advanced e-learning platforms. Indeed, the ability to process large amounts of data and respond to the unique needs of learners is what makes AI so promising in this context. This has led to growing optimism about its potential to create more personalized and effective learning experiences. In higher education indeed, where institutions are grappling with an increasingly varied student population, rising enrollments and persistent inequalities in access to education, AI offers a compelling opportunity to rethink conventional teaching models.

In this evolving landscape, AI-powered tools of the type such as adaptive learning systems and intelligent tutoring platforms are seemingly valuable resources. The goal of these technologies is to tailor teaching to each student's strengths and needs, which could lead to greater commitment and better academic results. Nevertheless, despite the global hype surrounding the role of AI in education, most academic research to date has been spotlighted in high-income countries with strong digital infrastructures. There remains a significant knowledge gap in this area.

It is within this context that the present study was conceived. Focusing on Cadi Ayyad University (UCA), one

of Morocco’s largest and most diverse public universities, this research aims to assess the impact of AI on personalized learning and student performance. Beyond measuring effectiveness, the study seeks to understand the conditions under which AI tools succeed in improving learning outcomes. Specifically, it examines the role of discipline-specific factors, students’ initial academic levels, and access to technology, while also highlighting the often-overlooked role of teacher preparedness. This raises a series of key questions: To what extent does artificial intelligence contribute to improved academic performance in a Moroccan university setting? Do the effects of AI in education differ according to academic discipline or faculty? And what contextual factors - institutional, technological or social - are likely to enhance or weaken its impact on student learning outcomes? The present study makes a dual contribution. Firstly, it contributes to filling a significant gap in the existing literature by providing empirical evidence anchored in the context of the Global South. Secondly, it demonstrates practical, evidence-based information that can guide the development of inclusive, context-appropriate educational policies.

Thus, the research aims to help educators, policymakers and university leaders make informed and equitable decisions regarding the implementation of AI tools in higher education. To delve into the issues, the research is organized into three main sections. The first provides a detailed review of theoretical frameworks and empirical studies relating to the role of AI in education. The second section outlines the research design and methodology, including the way data was collected, how econometric models were applied and how key variables were defined. The main findings of the study are presented in the final section, and their implications for educational policy and institutional practice are discussed.

XLII. Motivation & Methodology Academic literature review: theoretical and empirical perspectives

A. Introduction to the literature review

Artificial Intelligence (AI) has become a central theme in discussions on the future of education. While its potential to personalize learning is well documented in the theory, actual results vary widely depending on context, infrastructure, pedagogical design, and human mediation. This literature review synthesizes both theoretical frameworks and empirical findings to better understand the conditions under which AI contributes to academic performance. It also identifies major gaps, particularly in the context of higher education in developing countries such as Morocco.

B. Theoretical foundations of ai in education

AI-driven education builds upon several well-established pedagogical theories. According to Baker and Inventado (2014), AI systems are capable of analyzing real-time learning data and adjusting pedagogical content accordingly, aligning with the principles of adaptive learning. This individualized approach resonates with Vygotsky’s (1978) concept of the zone of proximal development, which emphasizes scaffolding learners just beyond their current competence. Bloom’s (1984) "2 Sigma Problem" further supports the premise that personalized

instruction can significantly outperform traditional group-based methods. AI systems have the potential to replicate this personalized effect on a larger scale. However, Selwyn (2016) warns against a technocentric narrative, insisting that educational tools must be contextualized within social, cultural, and institutional realities.

C. Empirical evidence: promises and variability

Multiple studies have examined the effectiveness of AI in education, with often encouraging but context-dependent outcomes. A meta-analysis by Zawacki-Richter et al. (2019) covering 146 studies found that AI-based platforms produce an average effect size of $d = 0.45$, suggesting moderate yet consistent gains in academic performance. Holmes et al. (2021) observed that university students using adaptive platforms in Europe improved their scores by an average of 15%. These effects, however, differ markedly by discipline. Kizilcec et al. (2020) report that technical fields benefit the most due to the compatibility of AI with simulations and structured content, whereas humanities show weaker results due to the complexity of interpreting qualitative data (Ferguson & Clow, 2017).

Table 1. Summary of International Empirical Findings on AI in Education

Study	Sample / Context	AI Tool Type	Impact (Effect Size / Gain)	Discipline Sensitivity
Zawacki-Richter et al. (2019)	146 studies (international meta-analysis)	Intelligent tutors, adaptive apps	$d = 0.45$	Higher impact in STEM
Holmes et al. (2021)	European universities	Adaptive learning platforms	+15% academic performance	Technical fields > Humanities
Kizilcec et al. (2020)	Engineering students (US & Europe)	Simulations, virtual reality (VR)	High learning gains	Strong in Engineering, Mathematics
Ferguson & Clow (2017)	UK higher education institutions	NLP, learning analytics	Mixed results	Weak in social sciences

Source: Own elaboration.

D. Mediating Role of Teachers and Pedagogical Culture

A recurring theme in the literature is the central role of teachers in the successful implementation of AI. Ertmer and Ottenbreit-Leftwich (2010) argue that technological adoption depends as much on teacher beliefs and confidence as on infrastructure. Lawless and Pellegrino (2007) demonstrated that students taught by instructors trained in AI integration outperform others by 25%. Tondeur et al.

(2017) emphasize that professional development must be discipline-specific and continuous, not one-size-fits-all.

E. Structural Challenges in Developing Contexts

In many low- and middle-income countries, the adoption of AI in education is hampered by structural constraints: unreliable internet, under-equipped classrooms, and unequal access to digital devices. Van Dijk (2020) highlights the digital divide as a major barrier. In the Moroccan context, Maghni and El Khannouss (2024) report that only 30% of university students have access to the necessary infrastructure for AI-based learning. This underscores the need for inclusive educational policies and public investment in digital equity.

$$Y_i = \beta_0 + \beta_1 IA_i + \beta_2 NI_i + \beta_3 AT_i + \beta_4 X_i + \varepsilon_i$$

- Y_i : Academic performance (GPA out of 20)
- IA_i : Binary variable (1 = AI used, 0 = not used)
- NI_i : Initial academic level
- AT_i : Access to technology (1 = yes, 0 = no)
- X_i : Control variables (gender, age, study level)
- ε_i : Error term

Table 2. Structural Constraints and Levers for AI Integration in the Global South

Author(s)	Country / Region	Barriers Identified	Suggested Levers
Van Dijk (2020)	Global South	Digital divide, poor connectivity	Infrastructure investment
Maghni & El Khannouss (2024)	Morocco (UCA)	Low access to devices (30%), limited faculty training	Teacher capacity-building, targeted aid
Tondeur et al. (2017)	LMICs (multiple)	Generic training programs	Tailored, ongoing pedagogical support

Source: Own elaboration.

F. Synthesis and conceptual framework

Taken together, the literature points to a generally positive but uneven effect of AI on student outcomes. While promising results are evident in STEM fields and high-resource environments, challenges remain in less digitally mature institutions, particularly in the Global South. The literature also confirms that teacher training and technological access are key mediators of AI effectiveness. This study aims to fill a critical empirical gap by analyzing the impact of AI on academic performance in a Moroccan university context where disciplinary diversity and infrastructural inequalities intersect.

XLIII. METHODOLOGY

This study adopts a quantitative, econometric approach to assess the causal impact of artificial intelligence (AI) on students' academic performance within a personalized

learning framework. The empirical analysis was conducted at Cadi Ayyad University (UCA), a large Moroccan public university that includes a wide variety of academic disciplines and faculties. To ensure the reliability and validity of our results, we mobilized two complementary econometric models: a multiple linear regression (MLR) and a difference-in-differences (Diff-in-Diff) design. These approaches allow us not only to estimate the net effect of AI usage, but also to explore variations across time and between groups.

The dataset consists of information collected from 124 students enrolled in 12 faculties and schools, spanning disciplines such as sciences, law, engineering, humanities, and medicine. A structured questionnaire gathered data on academic performance (GPA), AI tool usage, technology access, initial academic level, and various demographic and educational control variables.

A. Multiple Linear Regression (MLR) Model

The first econometric specification is a standard linear model aimed at estimating the direct association between the use of AI tools and academic performance:

Table 3. Description of Variables Used in the MLR Model

Variable Code	Variable Name	Type	Description
Y_i	Academic Performance	Continuous	Final GPA (scale of 0–20)
A_i	AI Usage	Binary	1 if student used AI-based tools (adaptive learning, etc.), 0 otherwise
NI_i	Initial Academic Level	Continuous	GPA at the start of the academic year
AT_i	Access to Technology	Binary	1 if student has reliable access to internet & devices, 0 otherwise
<i>Gender</i>	Gender	Categorical	Male / Female
<i>Age</i>	Age	Continuous	Student's age (in years)
<i>Study_Level</i>	Level of Study	Categorical	Year of study (Bachelor 1–3, Master 1–2)

Source: Own elaboration.

B. Difference-in-Differences (Diff-in-Diff) Model

To assess the causal impact of AI adoption over time, we implemented a Difference-in-Differences approach. This model estimates the average treatment effect by comparing changes in academic performance between two groups (treatment and control) before and after AI was introduced.

$$Y_{it} = \alpha + \beta_1 \cdot Post_t + \beta_2 \cdot Treatment_i + \beta_3 \cdot (Post_t \times Treatment_i) + \gamma \cdot X_{it} + \epsilon_{it}$$

Where:

- Y_{it} : Academic performance of student i at time t ;
- $Post_t$: Binary variable (1 = post – AI intervention, 0 = pre – intervention);
- $Treatment_i$: Binary group membership (1 = AI user, 0 = non – user)
- $Post_t \times Treatment_i$: Interaction term capturing the treatment effect;
- X_{it} : Vector of time-varying control variables;
- ϵ_{it} : Error term.

This approach ensures that any observed performance gain can be attributed to the use of AI, net of time trends and group differences.

C. Robustness checks and diagnostic tests

To validate the assumptions underlying our econometric models and ensure the reliability of our results, several post-estimation diagnostic tests were conducted. These tests assess the presence of heteroskedasticity, autocorrelation, multicollinearity, and potential model misspecification.

Table 4. Description of Variables Used in the MLR Model

Test Name	Purpose	Method/Threshold
Variance Inflation Factor (VIF)	Detect multicollinearity among independent variables	VIF < 5
Breusch-Pagan Test	Test for heteroskedasticity of residuals	$p > 0.1$
Durbin-Watson Statistic	Detect autocorrelation in residuals	$1.5 < DW < 1.5$
Ramsey RESET Test	Verify model specification (functional form)	$p > 0.1$

Source: Own elaboration.

These diagnostic results confirm that our models are statistically robust and properly specified for inference.

D. Ethical considerations and data confidentiality

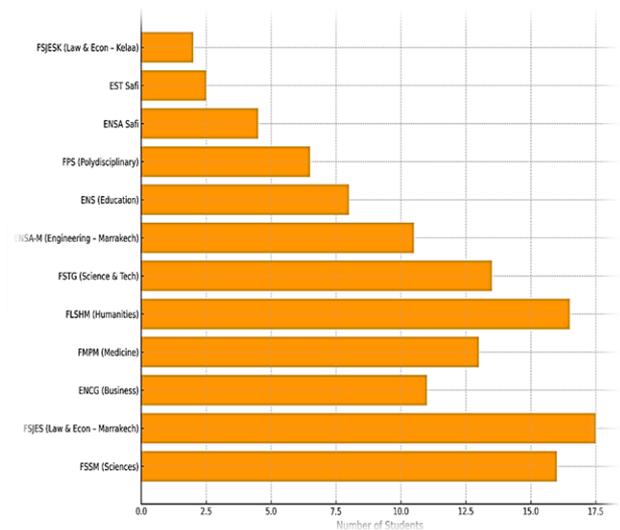
All data were collected with the informed consent of participants. Anonymity and confidentiality were guaranteed. The research protocol adhered to the ethical

standards set by the university’s social science research committee.

XLIV. RESULTS

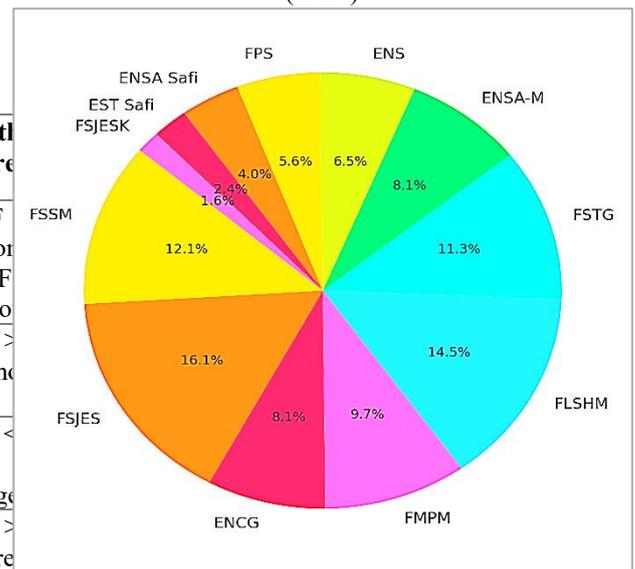
This section presents the detailed results of the econometric analysis conducted to evaluate the impact of Artificial Intelligence (AI) on personalized learning and the academic performance of students at Cadi Ayyad University (UCA). The results are organized into subsections and are accompanied by tables and figures for better understanding.

Figure 1: Distribution of Students by Faculty (UCA)



Source: Own elaboration.

Figure 2: Percentage Distribution of Students by Faculty (UCA)



Source: Own elaboration.

A. Descriptive Statistics

Table 5 : Sample Characteristics

Variable	Mean	Std Deviation	Min	Max
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Academic Performance	13.2	2.5	8.0	18.5
Age	21.5	2.1	18	28
Initial Level	12.8	2.3	7.5	17.0
Use of AI (%)	65%	–	0	1
Access to Technology (%)	70%	–	0	1

Source: Own elaboration.

The sample consists of students with an average academic score of 13.2 out of 20. Approximately 65% of the students used AI tools, and 70% have adequate access to technological resources.

Table 6: Results of the Multiple Linear Regression Model

Variable	Coefficient	Standard Error	p-value	Significance
Use of AI	1.75	0.32	0.000	***
Field (Ref: FSSM)				
– FSJES	-0.45	0.28	0.110	NS
– ENSA-M	1.20	0.35	0.001	***
– FLSHM	-0.30	0.31	0.330	NS
Initial Level	0.60	0.10	0.000	***
Access to Technology	0.90	0.25	0.000	***
Constant	8.50	0.75	0.000	***

Source: Own elaboration.

The use of AI increases academic performance by an average of 1.75 points, all other factors being equal. Students from ENSA-M perform 1.20 points higher than those from FSSM. Initial academic level and access to technology also have a significant positive impact.

B. Difference-in-Differences (Diff-in-Diff) Analysis

Table 7: Results of the Diff-in-Diff Analysis

Variable	Coefficient	Standard Error	p-value	Significance
Post (Post-AI Period)	0.50	0.20	0.012	**
Treatment (AI Use)	0.80	0.25	0.001	***
Post × Treatment	1.30	0.30	0.000	***
Constant	12.0	0.50	0.000	***

Source: Own elaboration.

Legend:

- *** = significant at 1%
- ** = significant at 5%

The effect of AI (interaction term Post × Treatment) is 1.30 points, indicating a significant improvement in academic

performance after the introduction of AI tools. This effect is both causal and robust, confirming hypothesis H1,

C. Variations Across Faculties

Table 8: Impact of AI by Faculty

Faculty	AI Impact (Coefficient)	Standard Error	p-value	Significance
FSSM	1.50	0.35	0.000	**
FSJES	0.80	0.30	0.008	**
ENSA-M	2.00	0.40	0.000	**
FLSHM	0.60	0.25	0.018	**
FSTG	1.80	0.38	0.000	**

Source: Own elaboration.

Legend:

** = significant at 5%

The impact of AI is highest at ENSA-M (+2.00 points) and FSTG (+1.80 points), confirming hypothesis H2. The social sciences faculties (FSJES, FLSHM) show more modest but still significant gains.

D. Moderating Effects

Table 9: Moderating Effects of Initial Academic Level and Access to Technology

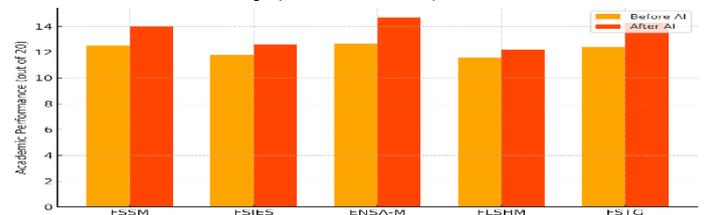
Interaction	Coefficient	Standard Error	p-value	Significance
AI × Initial Academic Level	0.25	0.08	0.002	***
AI × Access to Technology	0.40	0.10	0.000	***

Source: Own elaboration.

The effect of AI is stronger for students with a low initial academic level (coefficient = 0.25). Access to technology also amplifies the impact of AI (coefficient = 0.40), confirming hypotheses H3 and H4.

E. Results visualization

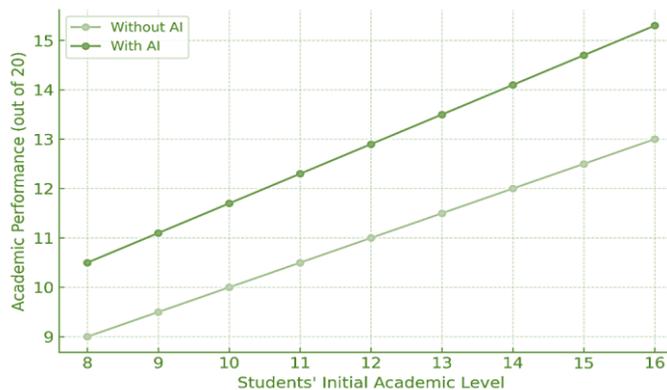
Figure 3: Impact of ai on academic performance by faculty (before/after ai)



Source: Own elaboration.

This figure highlights a significant improvement in academic performance following the introduction of AI, particularly in science and engineering faculties.

Figure 4: Moderating Effect of Initial Academic Level



Source: Own elaboration.

The graph shows that the impact of AI is more pronounced among students with a lower initial academic level, confirming the presence of a differentiated moderating effect.

XLV. CONCLUSION

This research set out to examine the impact of artificial intelligence (AI) on personalized learning and academic outcomes among students at Cadi Ayyad University (UCA), a major institution in Morocco's higher education landscape. The results clearly indicate that AI technologies can enhance academic performance when appropriately implemented. Students who used AI-supported tools such as adaptive learning platforms or virtual tutoring systems achieved significantly higher scores than their peers, reinforcing the view that AI can be a powerful lever for educational transformation—particularly in settings where challenges like overcrowded classrooms and regional inequities remain entrenched.

Yet the findings also bring to light important disparities. The benefits of AI are not evenly distributed: students with better access to technology and those starting from lower academic baselines appear to benefit the most. This uneven impact underscores a persistent digital divide and suggests that, without deliberate intervention, AI might risk reinforcing existing inequalities rather than reducing them. Moreover, the role of teacher training—though recognized as essential in the literature—remains under-explored in the present study, due to limited data availability. This points to a need for more targeted investigations into how faculty readiness shapes AI effectiveness.

As with any study, certain limitations should be acknowledged. First, the possibility of self-selection bias cannot be ruled out: students who chose to engage with AI tools may also have been more motivated or better resourced from the outset. Second, the lack of detailed information on the frequency and nature of AI tool usage constrains the depth of interpretation. Third, the context-specific nature of UCA both in terms of institutional characteristics and student demographics limits the generalizability of the results to other settings, particularly those with different levels of technological development.

Despite these constraints, the study opens promising avenues for future research. A longitudinal approach could help evaluate whether the observed academic gains are

sustained over time. Cross-country comparative studies especially in other Global South contexts would also help clarify how socio-economic and institutional factors mediate the impact of AI. In addition, a deeper analysis of the pedagogical strategies adopted by AI-trained instructors would shed light on the human element behind successful technology integration. Lastly, there is scope to explore innovative policy mechanisms, such as public–private partnerships, digital inclusion grants, and community-based training programs, aimed at mitigating the unequal access to AI tools.

From a practical standpoint, the study offers several actionable insights for policymakers and education leaders. Investing in robust digital infrastructure must be a priority, particularly in underserved regions. Equally important is the continuous professional development of educators, to ensure that AI technologies are used not just technically, but pedagogically. Inclusive policy measures such as scholarships, hardware subsidies, and access facilitation for marginalized students can contribute to reducing inequality in the educational use of AI. Finally, AI tools must be customized to suit the epistemological and methodological specificities of different academic disciplines, if they are to be truly effective.

In sum, this study provides empirical evidence of AI's potential to enhance learning in a Moroccan higher education context, while simultaneously highlighting the conditions necessary for its equitable and impactful integration. It contributes to the growing international dialogue on the role of emerging technologies in education and offers a foundation for further studies aimed at understanding how innovation can serve the broader goal of inclusive and quality learning for all.

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Developing writing competence with AI in high school: a self-study on the guided use of a writing assistant

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Abstract

This research examines the educational impact of artificial intelligence (AI) technologies on the development of writing skills in secondary education, an area that has been little studied despite the transformative potential of these digital tools. Our study, which is qualitative and reflective in nature, is part of a self-study approach focused on the personal use of AI-based writing assistants, namely: Deepseek, Qwen AI and Monica AI. Through critical analysis of our own writing and revision process, we explore the real effects of these tools on the development of writing skills among secondary school students, while assessing the challenges and opportunities they present.

The results are very satisfactory and confirm the potential of these AI models to help students improve their writing skills. In addition, this study takes stock of the adoption of these tools by teachers. The conclusions of this study open up avenues for reflection and formulate useful recommendations for teacher training and the effective integration of AI technologies into teaching.

Keywords: *Artificial Intelligence, AI Models, Writing Skills.*

Introduction

Although secondary school students are encouraged to develop their writing skills, many still struggle to acquire them. As Bonnéry and Rispaïl (2021) point out, evaluating these learning processes is a complex challenge in terms of long-term research. Indeed, the integration of AI-powered writing assistants allows for the development of new personalised and self-directed learning tools. However, there is a lack of documentation on the effectiveness of these strategies in an educational context, particularly for the development of writing skills through guided self-learning.

This research therefore examines how these assistants can contribute to the development of learning skills, particularly with regard to writing skills. The main aim of this study is to assess the relevance of these digital learning tools in the field of education, specifically their impact on the acquisition of learning skills. It is based on written work produced in secondary school and

answers the following question: to what extent can learners improve the quality of their writing by using intelligent assistants such as Deepseek, Qwen AI or Monica AI (non-exhaustive list)?

The data analysis focuses on the influence of the correction, rephrasing and feedback features offered by these language models. In addition, it highlights preferred writing strategies, such as rewriting, vocabulary enrichment and idea structuring. Through self-experimentation, this research aims to better understand the conditions for the critical and educational use of these technologies in the learning process, while taking into account their limitations, the risks of dependency, and the ethical issues they raise, particularly the loss of creativity and the question of student autonomy.

Our self-analysis is based on an operational methodological framework to examine, in a contextualised manner, the effect of these adaptive AI teaching aids on strengthening writing skills. Therefore, by focusing on a personal and well-defined experiment, it allows us to observe precisely the evolution of writing practices thanks to the multiple functionalities of these intelligent assistants, such as correction, rephrasing, feedback and other tools such as translation.

In short, it sheds new light on the conditions for AI-assisted autonomous learning in a field that is still poorly documented, while contributing to the debate on their rational integration into teaching practices.

Research question

Our analytical research approach is based on a reflective study structured around a methodical approach aimed at evaluating the observable results of AI text-generating assistants in the acquisition of writing skills in the field of education. By combining pedagogical, cognitive and technological approaches, we examined the impact of these digital writing assistants on the development of writing skills among high school students.

Context

High-quality writing relies above all on the development of cross-disciplinary language skills. According to Phillips Galloway et al. (2020), these skills are essential for successful academic writing and also have a direct influence on academic performance and even career paths. Writing is therefore seen as the main mode of assessment in the education system, which is largely oriented towards summative assessment methods (Barré de Miniac, 2000).

This area has been the subject of extensive research, demonstrating that changes in the methods used to assess written work significantly improve the quality of writing, with a marked differential impact on learners with difficulties. This improvement is due in particular to the integration of tools such as self-assessment, formative feedback and structured programmes for the development of self-regulated strategy development (SRSD) (Kim et al., 2021).

Today, writing is no longer limited to a simple exercise; thanks to these automated tutors, it is defined as an intellectual process that is both creative and reflective, allowing ideas to be expressed, organised and given meaning (Amaral, 2019). Furthermore, as a skill that is integrated into all disciplines, writing plays a central role in the development and transformation of ideas, thereby facilitating the acquisition of learning skills. Graham, Kihara and MacKay (2020) present another example: according to them, writing is much more than a simple means of expression; it actively contributes to the integration of knowledge and the structuring of thought.

Currently, as shown by Zawacki-Richter et al. (2019), it is essential to adopt a balanced approach to AI in language teaching and learning, combining technological revolutions with pedagogical frameworks. This ensures pedagogical differentiation while allowing each student to achieve fundamental objectives at their own pace and according to their specific educational needs.

The systematic integration of these teaching practices is a fundamental lever for reducing learning inequalities and implementing the principle of 'equity in education systems' (Demeuse et al., 2005). Furthermore, these double-edged digital tools require a systematic framework that incorporates a comprehensive reflection on the ethical and critical issues involved in their integration into the school environment. In this sense, Naymark (1999) asserts that 'the use of new technologies in education can be the best or the worst thing'. Thus, although they are widely adopted, writing assistants are often used only to make superficial corrections, thereby neglecting their deeper educational value.

1. State of the art

Our systematic review, consisting of a rigorous selection of academic publications (1981-2025), analyses the evolution of the educational uses of artificial intelligence (AI). The data comes from recognised databases: Scopus, Web of Science, ScienceDirect, Google Scholar and ResearchGate. Our analysis focuses on four main areas: the development of learning skills, case studies revealing mastery of writing, technological solutions for writing, and the ethical challenges of AI in education. Thanks to AI, learning skills is smarter than ever before. Current technological changes are enabling the use of digital teaching assistants and the adaptation of content to the specific needs of learners (Zhang, 2024). In addition, adaptive learning and automated assessment are now possible.

Advances in the field of natural language processing, which 'is a multidisciplinary field encompassing linguistics, computer science, logic, mathematics, and the philosophy of language and reasoning' (Biskri and Jibali, 2011, p. 16, cited by Hassani, 2016, p. 16), have led to the creation of autonomous writing assessment systems. These intelligent machines are capable of providing detailed feedback on various aspects, such as style, grammar and coherence. In this study, Wang et al. (2024) propose an innovative model that harmonises autonomy and support, self-assessment and grammatical correction, and consequently offers immediate and constructive feedback that is essential for the continuous improvement of writing skills.

AI, based on machine learning and deep learning techniques, UNESCO (2019), is redefining educational scenarios. This makes it possible to predict learners' results and identify potential difficulties in advance, thereby enabling tailored educational intervention strategies. Added to this are 21st-century tools, which now go beyond simple corrective functions. They effectively reinforce the development of learning skills, specifically writing proficiency, while strengthening creativity and critical thinking and encouraging self-regulation strategies. Furthermore, these features help to strengthen learner autonomy through motivation and engagement (Shafiee Rad, 2025).

These reflections will serve as a basis for studying how to intelligently integrate AI-based writing tools. Numerous studies, as highlighted by Mekaoussi (2024), also highlight the ethical issues surrounding technologies such as ChatGPT. Among other things, Li et al. (2023) add three main challenges to be addressed: confidentiality, algorithmic bias and academic integrity.

While real progress has been made in the existing literature, it must be noted that few studies have actually examined educational success and the acquisition of long-term learning skills. Writing skills, in particular, deserve in-depth investigation. This is a crucial point for developing communication and interculturality. Our research therefore seeks to answer the following question: how do these technologies

specifically influence the writing skills of high school students?

In this sense, these educational assistants act as technological resources capable of reducing or even eliminating learning inequalities, in line with UNESCO's recommendations (1981) on how to plan education with the aim of achieving greater equity. While offering individualised support to students with difficulties or from disadvantaged backgrounds, they promote their progress in written production.

For example, in special educational needs settings, this approach could form a pedagogical basis for consolidating writing skills. Indeed, there is no denying that AI in education is attracting growing interest; however, most research focuses on higher education or developed countries, while its effects in resource-poor contexts have been little studied. As Hassan Razouki et al. (2025) point out, its impact on learning remains mixed.

Mastery of writing, which is at the heart of language proficiency in the context of historical education (Allard et al., 2017), is the focus of our qualitative study, based on a self-analytical approach. Our objective is to determine the role of AI in the development of high school students' writing skills, particularly regarding self-learning and creativity, while identifying its limitations.

In summary, there is a lack of scientific literature on the integration of AI in secondary vocational education, particularly from the perspective of acquiring learning skills rather than assessment. This analysis provides didactic innovations and suggests avenues of research for profoundly changing didactic interactions. It also invites exploration of research areas aimed at ensuring the ethical and equitable use of AI.

2. Theoretical framework

In recent years, AI has radically changed the education sector by introducing new forms of learning and teaching tools tailored to the needs of learners and teachers. In fact, writing assistants such as Qwen AI, Monica AI and DeepSeek, which we have studied, are versatile resources that integrate AI-based technological solutions. Each model has specific functions that can be used according to the teaching objective.

In the context of language teaching and learning, these interactive resources offer several advantages. Firstly, they offer remarkable flexibility, being accessible and usable regardless of the learning location, thus making learning more adaptive and individualised. Secondly, they aim to promote personal development and professional integration among learners, while also helping teachers to refine their writing teaching methods. Thirdly, as formative assessment tools, they encourage autonomy, provide personalised learning and self-correction. In addition, they provide visible assessment benchmarks to guide and evaluate written work.

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Learners can, for example, use the grammar correction function, but also other features offered by these writing assistants, such as the translator, a particularly useful tool that is frequently used in class to enrich their vocabulary. They can thus easily switch between correction, translation and writing in a fluid and intuitive environment, which promotes the gradual improvement of their writing skills.

In the context of this study, we analysed academic writing learning from the perspective of cognitive models, notably that of Flower and Hayes (1981), which identifies three main mental operations involved in writing: planning, textualisation and revision. By intelligently combining digital tools and AI, we discovered that these technologies really do help students to write better.

Learning planning is facilitated by suggestions for improving ideas or structures guided by these AI models, which help organise students' thinking. Writing is enhanced by lexical and automatic paraphrasing features that modify the writing process and improve written expression. Finally, revision is also made very simple and gradual thanks to immediate feedback on grammar, style and coherence, allowing for self-regulated management and error control. Our analysis therefore highlights the mediating role of these intelligent writing assistants and tutors in the development and acquisition of writing skills in secondary education.

This research is part of a qualitative self-study (LaBoskey, 2004). This method favours reflective analysis. As Lunenberg et al. (2019) point out, it helps improve teaching practices by reflexively analysing teaching methods. It also offers the opportunity to test the use of these AI-based writing assistants to develop students' skills, while measuring their success during interaction with these intelligent models.

3. Methodology

In conducting our study, we adopted both a researcher and practitioner perspective in order to understand and evaluate the effect of the educational chatbot models in question—Qwen AI, Monica AI, and DeepSeek—on learning to write in secondary school. This dual approach enabled us to analyse the concrete consequences in detail, based on observations, logbooks and formative assessments. While our approach involves a degree of subjectivity, which is inherent in any action research, we placed great importance on the quality of our approach, while regularly questioning our methods and the real impact of these tools on learning.

Table 1: Description of the protocol (text corpus, reflective journal, AI tools).

Corpus (text written by a first-year science baccalaureate student)

In light of our reading of the work "Antigone", Creon exploited his power to try to protect his niece from death, Creon exploited his social status for Antigone, this subject has made a lot of ink and opinions are divergent, so what is the most logical and realistic opinion?

Some people say that we must exploit our social status, our power to achieve our interests and our goals, because these people say that their place in society can help these people to succeed and that they are lucky, most of these people are responsible and administrators, in society and it's simple to achieve his personal interests

But, on the other side there are people who say that social status, and is not a logical thing because there are those people who are able to occupy a business or an interest and another who is not able and with a little money and social status It will take the place of the other who makes great effort and works very hard, for that our society is materialistic and corrupt, and for that there is no equality between the candidates of everyone.

Date/session	Writing objective	AI tool used	Type of interaction	Perceived improvements	Personal reflections
03/03/2025 S1	Correction of an argumentative text.	Qwen AI	Rewording and correction	Greater clarity, increased confidence: Correction of spelling, grammar and punctuation errors.	<ul style="list-style-type: none"> Difficulty rephrasing a complex sentence. Progress after several attempts.
08/03/2025 S2	Lexical enrichment	DeepSeek	Lexical suggestions	More varied vocabulary, fluent expression: vocabulary enrichment and improved sentence fluency.	<ul style="list-style-type: none"> Lexical variations Enriched vocabulary.
15/03/2025 S3	Drafting and organising ideas.	Monica AI	Generating paragraphs and rephrasing	More fluid text, good structure with clear paragraphs: introduction, two argumentative sections (thesis/antithesis), and a conclusion.	<ul style="list-style-type: none"> Improvement and clarity by incorporating the proposed structure.

Source: developed by the authors

Table 2: Measurable impact of adopting AI solutions

Date	AI-supervised revisions	Changes	Observations
08/03/2025	Syntactic restructuring and optimisation of editorial cohesion	Certain ideas deemed too simplistic or inconsistent have been removed, e.g. 'to try to protect his niece' corrected to 'to protect his niece'. (paragraph 1)	Sentences restructured to optimise their fluidity and comprehensibility.
15/03/2025	Suggest relevant synonyms and common expressions.	Using the verb 'estimate' rather than 'say' enriches the lexical variety of the text. (paragraph 3)	Marked improvement in vocabulary diversity and stronger involvement
22/03/2025	Concordance and grammatical correction.	Correction of agreements, e.g. 'to exploit' corrected to 'has exploited'. (paragraph 1)	The student took almost all of the suggestions into account, which helped to improve clarity.
24/03/2025	Review of consistency and style, correction of errors.	Suggestion for rewording, e.g. 'because there are people like that' instead of 'Indeed, some individuals', for greater clarity. (paragraph 3)	The student has developed their independence and critical thinking skills.

Source: developed by the authors

Table 3: Evaluation criteria and analysis method.

Competence	Criterion	Performance level		Explanation
		Before AI	After AI	
Pragmatic skills	Adherence to instructions, overall coherence (logical sequence of ideas)	Average	Good	Reformulation of transitions.

	Text structure (introduction, body, conclusion)	Poor	Good	Proposal of a clear plan.
	Compliance with the rule of objectivity: Originality	Good	Very good	Improvement of several overly personal formulations.
Linguistic competence	Vocabulary (richness and lexical precision)	Average	Very good	More technical terms proposed.
	Syntax and grammar Correct	Poor	Very good	Very effective automatic correction.

Source: developed by the authors

Syntax	Automatic correction (grammar and conjugation) accompanied by suggestions to enrich the syntax (subordination, varied expressions).	✓ Immediate feedback allowing for instant corrections.
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Source: developed by the authors

Designed for learners, these AI models are intuitive and user-friendly, allowing everyone to progress at their own pace in learning to write. They do not require complicated instructions, as their relevant suggestions and clear interface make them true companions for progress, making writing improvement accessible and motivating.

4. Results

Our analysis focused on key features of our study, such as the ‘grammar checker’ and the ‘translator.’ These tools enable learners to quickly develop essential writing skills through utilities specifically designed to suit their needs. Among the concrete results observed:

- Better text structure.
- Enriched vocabulary and syntax.
- Nuanced perceptions of the contribution of AI.
- Awareness of limitations and risks (plagiarism, loss of authenticity, automatism).

The use of AI writing assistants has led to remarkable progress and benefits in several aspects of written production.

Table 4: Improvements observed (structure, vocabulary, syntax).

Aspects	Improvements	Observed benefits
Structure	AI supports text construction while structuring content (introduction/development/conclusion) and organising ideas (titles, connectors, paragraphs).	✓ Independent proofreading.
Glossary	The use of precise synonyms and lexical variety helps to create richer and more nuanced texts.	✓ Continuous improvement in writing quality.

Figure 1: Correcting an Argumentative Text

After reading Sophocles' *Antigone*, one might question Creon's motivations: did he truly act to protect his niece, or was he exploiting his power and social status for personal or political gain? This issue has sparked intense debate, with opinions sharply divided. So, what is the most logical and realistic perspective?

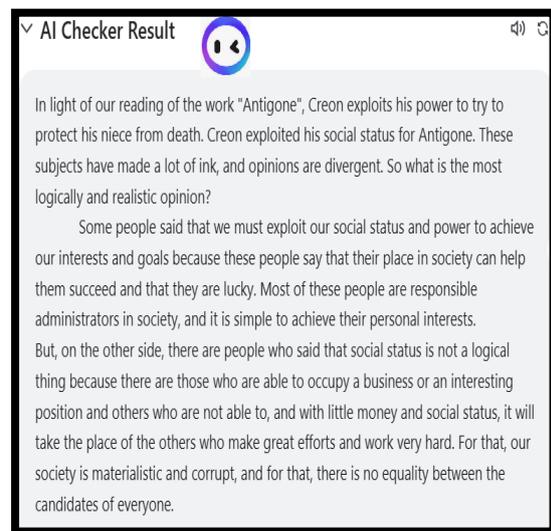
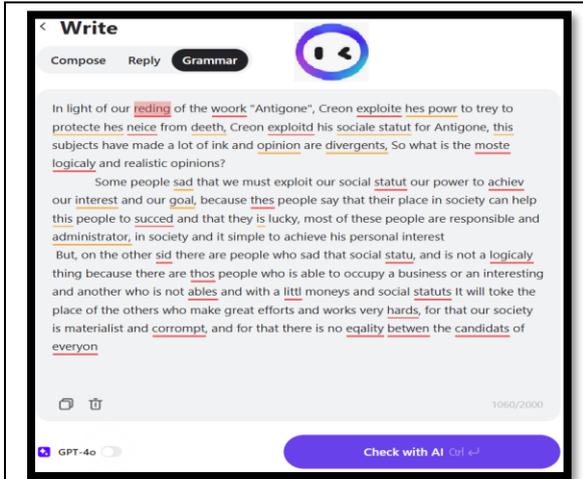
On one hand, some argue that individuals should use their social status and power to achieve their goals. They believe that one's position in society is a legitimate tool for success—especially when used responsibly. According to this view, those in positions of authority, such as leaders, administrators, or public figures, have earned their status and are therefore justified in leveraging it to protect their interests or support their families. After all, they argue, society functions more efficiently when people can rely on their influence to make decisions, especially in urgent or complex situations.

However, on the other side, many believe that relying on social status is neither fair nor logical. They point out that talent, effort, and hard work should be the true measures of opportunity—not wealth or connections. In reality, some individuals with little money or influence are denied opportunities, while others with powerful networks gain advantages regardless of merit. This imbalance, they argue, makes society increasingly materialistic and unjust. When privilege overrides effort, equality vanishes, and the system becomes corrupted.

In conclusion, while power and status can be used responsibly, as possibly intended by Creon in *Antigone*, their misuse threatens fairness and equality. A just society should not reward connections over competence. Therefore, the most realistic and ethical opinion is that social status should not override merit, and opportunities must be accessible to all, regardless of background.

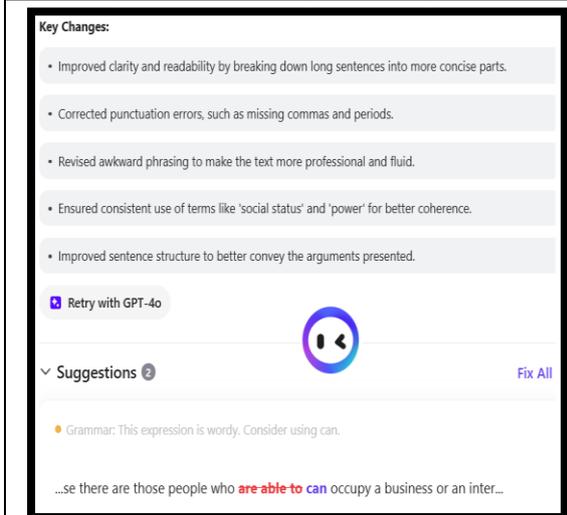
Source : <https://chat.qwen.ai/c/ea0fa962-0c3e-417b-a8d4-eba435429039>

Figure 2: Screenshot of AI grammar checker results



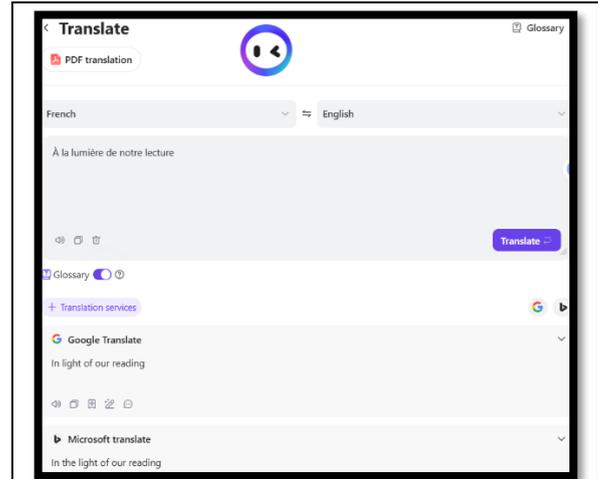
Source : <https://monica.im/home/write>

Figure 3: Key changes and suggestions



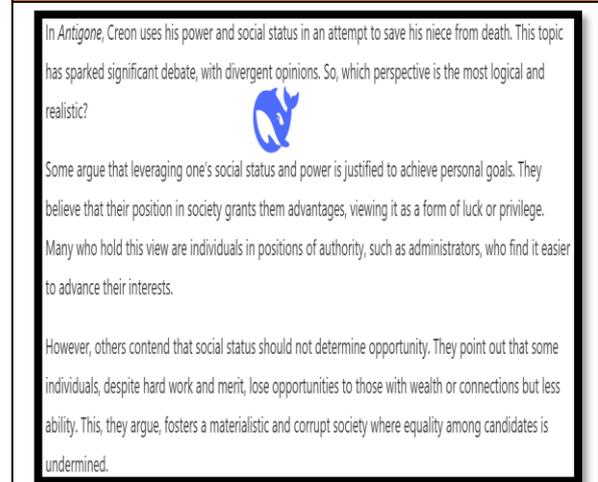
Source : <https://monica.im/home/write>

Figure 4: Translator



Source : <https://monica.im/home/write>

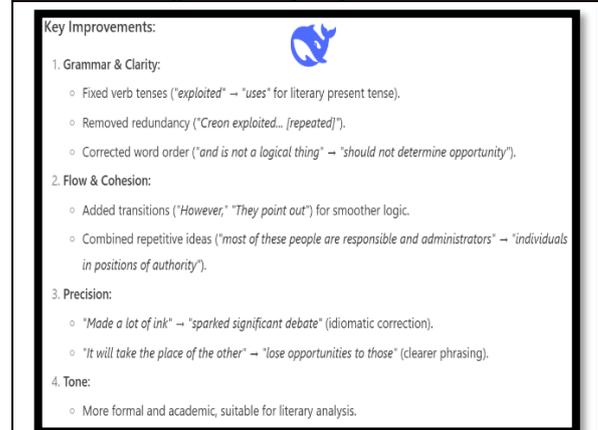
Figure 5: Screenshot of lexical suggestions and text enrichment



Source :

<https://chat.deepseek.com/a/chat/s/c06c50d9-b1e2-4e0c-ab8c-8a12aab6a654>

Figure 6 : key improvements



Source :

<https://chat.deepseek.com/a/chat/s/c06c50d9-b1e2-4e0c-ab8c-8a12aab6a654>

Grammar and style checkers help learners identify and correct their mistakes, while rephrasing suggestions enable them to improve the clarity and quality of their writing.

Personalised feedback tools offer automated assessment while providing targeted feedback on written work, highlighting strengths and areas for improvement. Through automatic analysis of structure, grammar and style, these tools facilitate teacher intervention and enable more individualised and effective support.

5. Discussion of teaching proposals

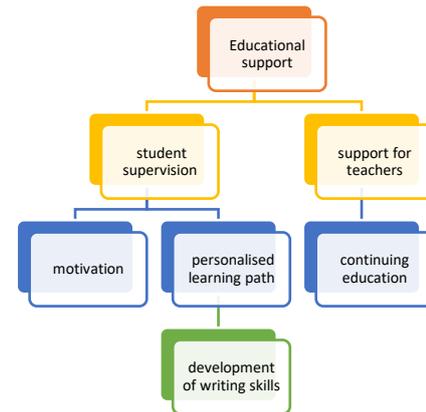
Although the use of these tools by some teachers remains limited, the texts generated retain a human stylistic imprint that is difficult to reproduce without precise individualised data, which demonstrates the complexity of natural writing. To effectively integrate AI-based assistants into the educational context, we believe three imperatives are essential: preserving learners' cognitive autonomy, maintaining the educational value of activities, and establishing a thoughtful balance between technological assistance and personal effort.

For the efficient integration of these educational AIs, it is necessary to formalise them while taking into account their ethical implications. These tools must be regulated to avoid harmful dependence on learning, involve teachers, educational designers and parents in this collective approach, and remind us that these assistants are supports and not substitutes, in order to preserve learners' motivation and editorial autonomy. Furthermore, it is essential to regulate the amount of time spent using these technologies to limit the risks of cyber addiction and strengthen cognitive skills.

These AI assistants can be considered complementary educational tools, provided they are integrated judiciously into writing instruction. We have noticed that they effectively support the development of writing skills, mainly in terms of linguistic correction and clarity of idea organisation. Nevertheless, technical improvements, such as image recognition (for certain features such as grammar correction), an offline mode and educational adjustments, are essential in the long term.

Feedback shows that the use of intelligent writing assistants paves the way for reducing gaps and repeated mistakes, thus demonstrating their value as adaptive learning tools. To this end, ongoing educational support (see the 'Educational support' chart) for both students and teachers remains central to the comprehensive development of writing skills in particular. To get the most out of them, it is essential to integrate these tools in a structured way into teaching practices, combining technological support with human guidance, in order to encourage both independent and original writing.

Graph 1: educational support



Source: developed by the authors

The limitations of this research are as follows: it focuses on a specific context and does not allow the results to be generalised to other profiles. The researcher's involvement introduces a risk of interpretative bias, a risk that is reinforced by the absence of external cross-validation.

We must ensure that AI does not erase the uniqueness of personal writing, which is often characterised by expressiveness and critical thinking that machines cannot reproduce. To achieve this, it is essential to train students in the vigilant, critical and ethical use of these digital platforms, in order to avoid any risk of loss of autonomy or intellectual property infringement. With supervision, these AI text generators can therefore become digital companions for self-learning, creativity and the development of writing skills.

Conclusion:

The results of our study reveal that AI assistants can truly support learners in their learning. We particularly appreciate their ability to identify linguistic errors and help structure ideas clearly. Functioning as a permanently accessible tutor, they suggest improvements while stimulating creativity and preserving the authenticity of each user. Their value lies less in replacing human writing than in improving it. However, several challenges related to the use of this new technology must be addressed, including technical and pedagogical issues, as well as the risk of excessive dependence.

We also confirm that the effectiveness of these generative AI tools lies in their ability to reduce persistent difficulties and develop writing skills. In fact, we believe that it is not the technology that makes the difference, but how it is used. We also note that the quality of writing fundamentally depends on teachers' understanding and training in AI.

In summary, this self-analysis leads us to the following conclusion: while AI is a concrete educational lever for strengthening autonomy and the quality of learning, its relevance depends on placing the student, not the machine, at the centre of the system. Therefore, the digital assistant must be considered as a pedagogical

support tool and not as a technology for mass delegation, thereby preserving the human dimension of textual creation.

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AI models:

1. <https://www.deepseek.com/en>
2. <https://monica.im/home>
3. <https://qwen.ai/home>

Determinants of Entrepreneurial Intention Among Moroccan University Students: Analysis of Motivational, Educational, and Contextual Factors

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Abstract—

Studying entrepreneurial intention has long been an important topic in the field of entrepreneurship. Since today's youth are potential future entrepreneurs, understanding their perception of contextual factors can contribute to the literature's development and is an important step in designing a more effective policy mechanism.

In this paper, we investigate entrepreneurial intention by applying the theory of planned behavior by Ajzen (1991) "The Theory of Planned Behavior (TPB)" which describes that intention of a behavior depends on attitude, social norm, and controlled behavior. In our context, the intention to start a business is thus a function of the three determinants, and we have also explored additional contextual determinants.

We have used qualitative and quantitative approaches to understand and explore the factors that explain the entrepreneurial intention of university students. In the first step, we conducted in-depth interviews with students from four universities in Morocco to explore the contextual determinants. Afterwards, we used the structural equation modeling technique to examine survey responses. Discussions of results are presented, and future research possibilities are suggested.

Keywords: *entrepreneurial intention, university students, quantitative approach, TBH incubation*

XLVI. INTRODUCTION

University entrepreneurship is a strategic lever for the professional integration of young graduates. In a constantly evolving job market, universities play a central role by integrating entrepreneurship education and

establishing incubators designed to support students in developing their projects.

Entrepreneurship has become a major economic and social phenomenon, a subject of academic research, and a field of teaching and education. Although entrepreneurship is not a new concept, it has regained prominence over the past two decades, especially in scientific research. Numerous educational programs have emerged in many schools and universities to encourage and introduce students to business creation. It is therefore essential to improve the efficiency of higher education in terms of raising awareness, providing training, and supporting young project holders.

There is no doubt that Morocco has made significant progress in this area. Policies supporting and promoting business creation have been implemented to encourage higher education graduates across several university institutions. These programs offer support, training, and financing opportunities. The initiatives differ from one another but aim to address an economic context marked by a relatively high unemployment rate among higher education graduates in Morocco.

Numerous initiatives have recently been launched to bridge the gap between entrepreneurs and funding or support opportunities, allowing them to benefit from training while sharing success stories in entrepreneurship. The current challenge is to find a model that combines financing and support, enabling project holders to access the best assistance under optimal conditions. Additionally, there is a need to reach a consensus on the content to be taught and the type of learning that can guide student behavior toward entrepreneurship.

This relatively recent experience in Morocco has led us to direct our scientific research towards studying the impact of attitudes and behaviors on students' entrepreneurial intentions. In this research, we focus on students' attitudes towards business creation, their entrepreneurial skills, and their

intentions to bring their projects to life. As a research field, we chose a new university incubator aimed at supporting students in the development of their projects.

This article aims to analyze how university incubation centers contribute to the training of young entrepreneurs and facilitate their integration into the labor market. Entrepreneurial behaviors and attitudes are collected from the database of students registered in the Moulay Ismail University incubation center, the TBH Tech Business Hub.

This scientific article contributes to the literature on encouraging youth entrepreneurship in two main ways:

- First, it is one of the first theoretical and empirical studies in Morocco to use behavioral and attitudinal variables related to entrepreneurial creation among students enrolled in an innovative program that supports Moroccan project holders. Most previous research has focused on financial ratios and behavioral indicators.
- Second, it examines the influence of incubation centers on students' entrepreneurial intention and their willingness to undertake entrepreneurial ventures.

The remainder of the article is structured as follows: It presents a literature review, the methodology used, the results obtained, and their practical implications.

XLVII. LITERATURE REVIEW:

For several years, research in entrepreneurship has focused on the project initiators within the entrepreneurial process. However, it is not enough to study only those who have already launched their businesses; it is equally important to understand individuals at the pre-launch phase. Studying entrepreneurial intention provides deeper insights into this phenomenon.

Several models and theories have attempted to explain the complexity of entrepreneurship. According to Krueger and Carsrud (1993), analyzing future entrepreneurial behavior is inseparable from studying the underlying intentions. Research by Kolvereid (1997), Bird (1988), and Ajzen (1988) confirms that entrepreneurial intention is the best predictor of entrepreneurial action.

This study is based on the Theory of Planned Behavior (TPB) developed by Ajzen (1991), which posits that entrepreneurial intention is influenced by attitude, perceived social norms, and perceived behavioral control. In our research, we specifically examine how entrepreneurial education impacts the entrepreneurial intentions of students from four Moroccan universities.

The Moroccan context remains in its early stages of developing an entrepreneurial ecosystem. Understanding how young people perceive contextual factors is crucial for designing more effective entrepreneurship support systems.

While this article does not seek to evaluate entrepreneurship education practices directly, its goal is to identify the variables that higher education should target to foster entrepreneurial intentions and behaviors among Moroccan students. The TPB serves as our main framework, emphasizing the role of attitude, social norms, and perceived control in shaping intentions.

Additionally, the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975) also provides insights into the

relationship between attitudes and behaviors, highlighting factors such as personal attitudes, the influence of time, and learning history. However, TRA has limitations, particularly regarding its focus on individual perceptions without fully considering the social context. To address this, Ajzen (1985) introduced perceived behavioral control into the TPB.

In entrepreneurial studies, both economic and psychological perspectives have been used to examine entrepreneurial intention. From an economic standpoint, fear of failure negatively impacts the willingness to start a business (Arenius & Minniti, 2005). Psychologically, motivation and the anticipation of success or failure play a major role (Duong & Vu, 2024).

Despite numerous studies, there is no consensus on the determinants of entrepreneurial intention among young people. Different authors have interpreted models such as those of Ajzen and Shapero in various ways. For example:

- Audet (2001, 2004) found that students who plan to start a business in the long term focus more on desirability (the desire to start) and perceived feasibility (the belief they can succeed).
- Kolvereid (1996) demonstrated that attitude toward entrepreneurship, perceived social pressure, and personal control significantly influence entrepreneurial intention, while personal characteristics (gender, background) have only indirect effects.
- Studies in different contexts (Russia, by Kolvereid & Isachenkov, 1999) confirm the robustness of this model across cultures.
- Krueger (2000) showed that for recent graduates, perceived competence and attitude are key factors, while social norms are less influential in career decisions.

Overall, research consistently highlights three core psychological dimensions of entrepreneurial intention: desirability, feasibility, and social norms. These dimensions form the empirical backbone of most studies, validating their relevance in diverse cultural and educational contexts.

Table. 1. Summary of Entrepreneurial Intention Studies

Author	Sample Context /	Theoretical Model Used	Significant Variables Identified
Kolvereid (1996)	128 Norwegian business school students	Theory of Planned Behavior (Ajzen)	Attitude toward entrepreneurship, social norm, perceived behavioral control
Tkachev & Kolvereid (1999)	567 Russian students	Theory of Planned Behavior (Ajzen)	Attitude, social norm, perceived control
Audet (2001, 2004)	150 business administration students (Canada)	Shapero & Ajzen Model	Perceived desirability, perceived feasibility

Krueger et al. (2000)	97 recent business school graduates	Theory of Planned Behavior (Ajzen)	Perceived feasibility, attitude toward action
Kennedy et al. (2003)	1,075 Australian students	Shapero & Ajzen Model	Desirability, feasibility, social norm
Tounès (2003)	178 French management students (Master's level)	Shapero & Ajzen Model	Desirability, feasibility, training, personal variables (age, background, specialization)

Entrepreneurial intentions are not the result of chance. They are formed at the intersection of mental representations, perceived resources, social influences, and personal backgrounds. To foster entrepreneurship among young people, institutions—such as universities, incubators, and public policies—must intervene at multiple levels: making entrepreneurship desirable, strengthening self-confidence, providing concrete support, and promoting inspiring role models.

Based on the theoretical framework mobilized, two main research axes have been identified, forming the hypotheses developed below.

H1: Attitudes and entrepreneurial behavior significantly influence entrepreneurial intention.

Behavioral models agree on the determining role of internal variables such as attitudes, beliefs, motivations, and self-perception in the emergence of entrepreneurial intention. Through this first research axis, we propose that these personal and social factors play a decisive role in shaping students' entrepreneurial intentions.

- H1.1: A positive attitude toward entrepreneurship fosters entrepreneurial intention. Here, attitude refers to an individual's personal evaluation of starting a business.
- H1.2: Perceived barriers to entrepreneurship are negatively associated with entrepreneurial intention. Psychological barriers (fear of failure, stress, lack of time) and contextual barriers (limited access to funding, bureaucracy, lack of support) act as inhibitors.
- H1.3: Personal motivations positively influence entrepreneurial intention. Entrepreneurship is often seen as a way to achieve personal goals such as autonomy, self-fulfillment, flexibility, or financial success.

H2: Involvement in the TBH incubation center has a positive impact on entrepreneurial intention.

In a more contextual approach, this second axis explores the influence of the university environment, specifically through the role of the Tech Business Hub (TBH) incubator at Moulay Ismail University. This center provides an entrepreneurial support and experimentation ecosystem. It is essential to assess how its presence and activities reinforce students' entrepreneurial intentions.

- H2.1: Active involvement in TBH activities is positively correlated with entrepreneurial intention. Participation in workshops, training, competitions, or projects offered by TBH allows students to directly engage with entrepreneurial realities. This

experiential learning fosters the confidence needed to seriously consider starting a business.

- H2.2: The specific objectives set when joining TBH positively influence entrepreneurial intention. Some students join TBH to benefit from specific services such as personalized support, access to funding, or the acquisition of entrepreneurial skills. When these goals are clear and motivating, they serve as a strong driver of entrepreneurial intention.
- H2.3: A positive evaluation of TBH is associated with a higher entrepreneurial intention.

The formulated hypotheses aim to test the influence of various determinants, both internal and external, on students' entrepreneurial intentions. They are based on a robust and contextualized literature review specific to Moulay Ismail University. The next step will be to translate these hypotheses into an empirical research protocol through a structured questionnaire, which will allow their validation on a student sample.

XLVIII. MOTIVATION & METHODOLOGY

A. Methodology

This study is based on a quantitative approach, utilizing an online survey for data collection. The objective is to gather measurable quantitative data to identify which variables determine entrepreneurial intention. The questionnaire was developed following the standards of the literature on student entrepreneurship, including Ajzen's Theory of Planned Behavior and motivational models.

Data analysis was performed using Python, which enabled robust statistical exploration through descriptive analysis, cross-tabulations, correlation tests, and graphical visualization of the results.

The target sample included all students enrolled in the Tech Business Hub (TBH), totaling 160 students. A convenience sampling method was adopted since the study focuses on a specific population directly exposed to the university entrepreneurial environment, allowing a better assessment of the incubation program's impact.

At the end of the data collection period, 90 complete responses were obtained, corresponding to a response rate of 56.25%. This rate is considered acceptable given the voluntary nature of the study and sufficient to support viable statistical analyses in an exploratory research context.

B. Data Analysis and Empirical Results

The following table presents the central tendencies (mean, median) and dispersion measures (standard deviation, minimum, maximum) of the main composite scores calculated from the questionnaire items. Each score represents a psychological or contextual construct, as defined in the entrepreneurial intention model applied at Moulay Ismail University.

Table. 2 : Descriptive Statistics of Composite Scores

This table presents the central tendencies (mean, median) and the dispersion (standard deviation, minimum, maximum) of the main composite scores calculated from the questionnaire

items. Each score represents a psychological or contextual construct, as defined in the entrepreneurial intention model applied at Moulay Ismail University.

Variable Label	Mean	Std Dev	Min	25 %	Median	75 %	Max
Personal Confidence	4.29	0.91	1.0	4.0	5.0	5.0	5.0
Creating a business = Valuable	4.58	0.75	1.0	4.0	5.0	5.0	5.0
Entrepreneurship = Motivating	4.41	0.81	1.0	4.0	5.0	5.0	5.0
Entrepreneurship = Good Solution	4.31	0.9	1.0	4.0	5.0	5.0	5.0
Risk-taking = Barrier	2.54	1.15	1.0	2.0	5.0	5.0	5.0
Entrepreneurial Stress	3.43	1.39	1.0	3.0	5.0	5.0	5.0
Motivation: Success / Job Creation	4.33	0.92	1.0	4.0	5.0	5.0	5.0
Barrier: Lack of Funding	3.63	1.26	1.0	3.0	5.0	5.0	5.0
Family Support	4.19	1.19	1.0	4.0	5.0	5.0	5.0
Control: Self-Confidence	3.97	1.03	1.0	3.0	5.0	5.0	5.0
Participation in TBH: Workshops	3.0	1.21	1.0	3.0	5.0	5.0	5.0
Evaluation of TBH Actions	3.96	1.11	1.0	3.0	5.0	5.0	5.0

To examine the direct relationships between the studied variables and entrepreneurial intention, a bivariate correlation analysis was conducted using Pearson's coefficients (for linear relationships) and Spearman's coefficients (for monotonic relationships, suitable for ordinal scales). This step allows for the identification of factors that show a significant level of association with entrepreneurial intention, prior to considering multivariate modeling. The results are presented in the following table

Table 3 : Bivariate Correlation Analysis Results

Score	Pearson r	p (r)	Spearman ρ	p (ρ)
Motivation_score	0.528	0.0	0.389	0.0002
Objectifs_TBH_score	0.267	0.0111	0.263	0.0121
Attitude_score	0.245	0.0201	0.28	0.0075
Evaluation_TBH_score	0.171	0.108	0.189	0.0746

Implication_TBH_score	0.184	0.0822	0.059	0.5781
Control_score	0.112	0.2951	0.188	0.0753
Support_score	0.128	0.2289	0.165	0.1203
Barriers_score	-0.138	0.1948	-0.14	0.1883

Factors Strongly Correlated with Entrepreneurial Intention:

- Personal motivation shows the strongest correlation with entrepreneurial intention ($r = 0.528$; $p < 0.001$). This means that the more students feel motivated—by factors such as personal achievement, financial autonomy, or flexible working hours—the higher their entrepreneurial intention. This strong correlation clearly indicates that motivation is a major and central lever for encouraging entrepreneurship among students at Moulay Ismail University.

Factors Moderately Correlated with Entrepreneurial Intention:

- Goals set within the Tech Business Hub (TBH) show a moderate correlation with entrepreneurial intention ($r = 0.267$; $p = 0.011$). When students enter the program with specific goals (such as acquiring skills, receiving tailored support, accessing funding, or participating in competitions), their entrepreneurial intention increases moderately. This suggests that the university incubator plays a positive, though less central, role compared to intrinsic motivation.
- Attitude toward entrepreneurship also shows a weak to moderate but significant correlation with entrepreneurial intention ($r = 0.245$; $p = 0.020$). The more students perceive entrepreneurship positively (seeing it as less risky, more enriching, and more fulfilling than traditional employment), the stronger their entrepreneurial intention. However, this relationship is somewhat fragile due to moderate internal consistency of the construct (Cronbach's $\alpha = 0.44$).

Factors Weakly or Not Significantly Correlated with Entrepreneurial Intention:

- Perceived barriers (such as administrative difficulties, lack of funding, or limited skills) show a weak negative correlation that is not statistically significant ($r = -0.138$; $p = 0.195$). This result indicates that, in isolation, perceived barriers do not significantly reduce students' entrepreneurial intentions. Further analysis could help explain this weak direct influence.
- Perceived support from family or institutions displays a weak positive but non-significant correlation ($r = 0.128$; $p = 0.229$). Social or institutional support alone is therefore not sufficient to directly strengthen entrepreneurial intention among the surveyed students.
- Perceived control (related to available resources and confidence in one's skills) also shows a weak, non-significant correlation ($r = 0.112$; $p = 0.295$). Although intuitively control perception might

influence intention, this factor does not appear to play a decisive direct role in this study.

- Students' involvement in TBH activities ($r = 0.184$; $p = 0.082$) and the overall evaluation of TBH's impact ($r = 0.171$; $p = 0.108$) show weak, non-significant positive correlations. These results indicate that mere participation or satisfaction with TBH activities does not have a sufficiently strong direct impact to significantly influence entrepreneurial intention on its own.

C. Global Explanatory Modeling

The global multiple linear regression model is used to simultaneously test the influence of all individual factors (Attitude, Motivation, Barriers, Support, Perceived Control) and contextual factors related to the Tech Business Hub (TBH) (Involvement, Goals, and Evaluation) on students' entrepreneurial intention.

Table. 4 : Multiple Linear Regression – Combined Effect of Factors

Variable	β (coef)	t	p	95% CI
Constant	2.569	4.1	0.0	[1.322; 3.816]
Attitude_score	0.112	1.11	0.269	[-0.088; 0.312]
Motivation_score	0.432	4.5	0.0	[0.241; 0.623]
Barriers_score	-0.056	-0.57	0.57	[-0.253; 0.140]
Support_score	-0.027	-0.3	0.766	[-0.207; 0.153]
Control_score	-0.094	-0.81	0.423	[-0.326; 0.138]
Involvement_TBH_score	0.027	0.4	0.691	[-0.106; 0.159]
Goals_TBH_score	0.053	0.52	0.604	[-0.149; 0.255]
Evaluation_TBH_score	0.021	0.24	0.813	[-0.156; 0.198]

Main Model Statistics

- Adjusted $R^2 = 0.237$: The model explains about 24% of the total variance in students' entrepreneurial intention. This is considered a moderate but relevant explanatory power in social sciences.
- $F(8, 81) = 4.45$, $p < 0.001$: The model is statistically significant, meaning that the variables collectively contribute significantly to predicting entrepreneurial intention.

Among all the examined factors, only Motivation emerges as a significant predictor:

- Motivation ($\beta = 0.432$; $p < 0.001$): This high coefficient clearly indicates that the more motivated the students are, the stronger their entrepreneurial intention becomes. Motivation is therefore the central factor directly influencing their entrepreneurial intention.

The other variables, although included in the model, are not significant when considered simultaneously with motivation:

- Attitude ($\beta = 0.112$; $p = 0.269$)
- Barriers ($\beta = -0.056$; $p = 0.570$)
- Support ($\beta = -0.027$; $p = 0.766$)

- Perceived Control ($\beta = -0.094$; $p = 0.423$)
- TBH Program Dimensions:
 - Involvement ($\beta = 0.027$; $p = 0.691$)
 - Goals ($\beta = 0.053$; $p = 0.604$)
 - Evaluation ($\beta = 0.021$; $p = 0.813$)

These results suggest that when personal motivation is already accounted for, the other factors, although they may have shown significant bivariate relationships, no longer sufficiently contribute to directly explaining entrepreneurial intention. However, their role could be indirect or moderated by other variables.

- Individual Hypothesis Testing

Simple regressions were also conducted to test the direct and isolated effect of each individual and contextual factor on entrepreneurial intention.

- Factors with Strong or Moderate Significant Effects:
 - Motivation ($\beta = 0.485$; $p < 0.001$; Adjusted $R^2 = 0.270$): This is the strongest effect observed in all the regressions. Motivation alone explains about 27% of the variance in entrepreneurial intention, representing a very high explanatory power. Highly motivated students clearly show a much stronger entrepreneurial intention.
 - Goals set within the TBH Program ($\beta = 0.209$; $p = 0.011$; Adjusted $R^2 = 0.061$): This TBH-related factor has a moderate explanatory capacity (about 6% of explained variance). When students have specific goals within the program, their entrepreneurial intention significantly increases.
 - Attitude toward Entrepreneurship ($\beta = 0.214$; $p = 0.020$; Adjusted $R^2 = 0.049$): This result highlights a moderate but significant relationship. A positive attitude toward entrepreneurship (less fear of risk, more positive perceptions) significantly strengthens entrepreneurial intention, although the effect is smaller compared to motivation.
- Factors with No Significant or Weak Explanatory Effect:
 - Involvement in TBH activities ($\beta = 0.105$; $p = 0.082$): This indicates a trend towards a weak but non-significant effect. Simply participating in TBH activities is not enough, by itself, to strongly increase entrepreneurial intention.
 - Overall Evaluation of TBH ($\beta = 0.105$; $p = 0.108$): The positive evaluation of the program, while important, does not directly suffice to influence entrepreneurial intention alone.
 - Perceived Barriers ($\beta = -0.124$; $p = 0.195$), Perceived Support ($\beta = 0.105$; $p = 0.229$), and Perceived Control ($\beta = 0.104$; $p = 0.295$): These factors show no significant direct effects, indicating they do not substantially alter

entrepreneurial intention when considered independently.

These findings suggest that factors like barriers, support, or perceived control may act indirectly or in combination with other variables.

XLIX. DISCUSSION AND RECOMMENDATIONS – INTERPRETATION OF RESULTS

The study conducted at Moulay Ismail University (UMI) aimed to explore the determinants of students' entrepreneurial intention, with a particular focus on the role of the Tech Business Hub (TBH). Rigorous statistical analysis identified the key factors explaining this intention while validating several dimensions from established theoretical models.

The multivariate analysis shows that personal motivation is the most significant and explanatory factor of entrepreneurial intention among UMI students. This finding is supported by a strong correlation ($r = 0.528$) and a significant regression coefficient ($\beta = 0.432$; $p < 0.001$), explaining nearly 27% of the variance in entrepreneurial intention. This result demonstrates that a high level of motivation—whether internal (personal fulfillment, creativity) or external (financial independence, flexibility)—strongly promotes the decision to engage in entrepreneurship.

These findings are consistent with the work of Krueger (2000), who states that motivation is essentially a "desire to act" that triggers entrepreneurial intention. Similarly, in the Theory of Planned Behavior (Ajzen, 1991), motivation—through attitude and perceived control—is identified as a key antecedent of intention.

Additionally, the analysis revealed that attitude toward entrepreneurship is an important, though secondary, but still significant factor ($\beta = 0.214$; $p = 0.020$) in predicting entrepreneurial intention. A positive attitude, including a favorable perception of entrepreneurship (as a rewarding and fulfilling career path) and reduced concerns about negative aspects (such as risk and stress), positively contributes to this intention. In other words, students who perceive entrepreneurship as a valuable, fulfilling, or socially meaningful activity are more likely to express an intention to start their own business.

This dimension refers directly to Ajzen's Theory of Planned Behavior (1991), where attitude is one of the three fundamental pillars of intention. Our results confirm that a positive attitude toward entrepreneurship, when based on favorable expectations of outcomes, indeed strengthens entrepreneurial intention, though its effect remains less substantial than that of motivation.

L. The Role of the Tech Business Hub (TBH)

The results show a moderate but significant influence of TBH. Among the assessed dimensions, only the goals set by students within the TBH program were found to be significant ($\beta = 0.209$; $p = 0.011$). Students who define clear objectives (such as acquiring new skills, accessing funding, or benefiting from personalized mentoring) demonstrate a higher entrepreneurial intention.

This outcome supports the findings of Fayolle & Gailly (2015), who highlight the importance of clear learning objectives in entrepreneurship education programs to

effectively stimulate entrepreneurial intentions. According to their research, the effectiveness of a program depends not only on its content or student participation but on how well the program objectives align with participants' expectations.

These results indicate that TBH has a positive impact only when the support objectives are clearly defined and aligned with students' entrepreneurial goals.

On the other hand, involvement in TBH activities and overall evaluation of the program did not show a significant direct effect on entrepreneurial intention. This suggests that simple participation or a positive perception of the program's utility is not sufficient; what truly matters is the initial intentionality and the student's ability to project themselves into concrete entrepreneurial objectives.

LI. Factors with No Significant Direct Effect

In this particular context, perceived barriers, perceived control (available resources and confidence in personal competencies), and perceived support (family or institutional) did not show significant direct effects on entrepreneurial intention.

This does not mean these factors are irrelevant but rather that they likely play an indirect or mediating role, potentially in combination with other variables such as motivation or the objectives set within the TBH program. This interpretation aligns with Shapero & Sokol's (1982) Entrepreneurial Event Model, which suggests that these factors may influence entrepreneurial intention indirectly, through motivation or self-confidence.

Our results indicate that for students at Moulay Ismail University, it is primarily their personal motivations and clearly defined entrepreneurial objectives that shape their desire to engage in entrepreneurship. This dynamic goes beyond simply perceiving a favorable or unfavorable environment; it is based on internal drivers, closely linked to the individual will to embark on an entrepreneurial project.

In summary, these findings confirm the primacy of individual psychological factors, especially motivation, in the formation of entrepreneurial intention. They also suggest that for the Tech Business Hub (TBH) to maximize its impact, it must prioritize these intrinsic dimensions.

This implies, in particular, the need to clarify students' personal and professional objectives at the very start of the program, so they can concretely and sustainably project themselves into the entrepreneurial process.

LII. Conclusion

The validation of our model is based on a quantitative study, conducted with a total sample of 160 students, all exposed to the university entrepreneurial environment, which allowed for a better understanding of the impact of incubation mechanisms. At the end of the study period, the final sample was composed of students who are only a few months away from entering the job market.

These results provide answers to the research question: students' entrepreneurial intention within the TBH mainly depends on their individual dispositions, and the role of the incubation center proves to be relevant as long as it supports this motivation with targeted guidance and a clear strategy for mentoring project initiators.

However, this study has several limitations. Since the TBH center is still in its launch phase, some support structures are not yet fully operational, which may affect students' perceptions. Additionally, the quantitative phase faced a low response rate: despite a target population of 160 enrolled students, the final sample was reached only after multiple follow-ups, including phone calls, resulting in 90 usable responses. This sample size remains modest and does not ensure optimal statistical representativeness.

These methodological limitations pave the way for future research, particularly through a longitudinal approach, allowing for the monitoring of intention evolution over time, or through the use of qualitative methods (interviews, focus groups) to enrich the interpretation of the results.

Furthermore, extending the study to other Moroccan university incubators and evaluating the long-term impacts of post-incubation would be promising avenues to strengthen the contributions of this work.

In conclusion, this study provides a useful contribution to understanding student entrepreneurial dynamics in an emerging academic context, and offers concrete recommendations for optimizing incubation mechanisms within Moroccan universities.

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