

Artificial Intelligence in Algerian Higher Education: A Theoretical Future Vision and Anticipation of Challenges

Meriem BALTA ^{1,*}

¹ August 20, 1955 University of Skikda (Algeria)
m.balta@univ-skikda.dz

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Abstract

This research paper aims to understand the future use of artificial intelligence (AI) in Algerian higher education by analyzing digital infrastructure and technical and human readiness. The findings revealed significant challenges Algerian universities face in applying AI, such as lacking infrastructure and specialized training. However, the study highlighted substantial opportunities to improve education quality through intelligent educational systems, adaptive learning, and personalized student support. The study recommends developing comprehensive strategies to enhance digital infrastructure, provide continuous training programs, and establish specialized research centers to support innovation, thereby improving the global competitiveness of Algerian educational institutions.

Keywords: Artificial Intelligence, Higher Education, Digital Infrastructure, Opportunities, Challenges.

* Meriem BALTA

1. Introduction

Over the past two decades, the world has witnessed significant advancements in artificial intelligence (AI) and its diverse applications. AI has become a major development driver in many fields, including higher education. Like other countries, Algeria strives to leverage this technology to enhance the quality of education and provide an advanced and efficient educational experience. AI in higher education can encompass various aspects, including curriculum development, improvement of teaching methods, and customization of the academic experience for each student. This research highlights the necessity of understanding and comprehending how AI can be used in Algerian higher education from a future theoretical perspective, as this understanding can provide a framework for developing effective policies and strategies.

Despite AI's significant potential, its application in Algerian higher education faces numerous challenges. These challenges include a lack of digital infrastructure, where many educational institutions lack the necessary modern devices and technologies to implement AI effectively. Additionally, there is a shortage of specialized competencies in this field, hindering the training of professors and students in using this technology. Integrating technology with traditional curricula is also difficult, as it requires redesigning curricula to fit AI applications. The research problem lies in overcoming these challenges and achieving effective and sustainable use of AI in Algerian higher education.

This research is of great importance due to AI's increasing role in improving the quality of education and developing educational curricula. AI can contribute to creating a more interactive and flexible learning environment where educational content can be tailored to the needs and abilities of each student. Through a future theoretical study, this research can provide insights and strategies to help decision-makers and academics in Algeria adopt AI effectively in the higher education system, thereby enhancing the competitiveness of Algerian educational institutions on the international level.

This research aims to provide a comprehensive theoretical vision for the future use of AI in Algerian higher education, focusing on the available challenges and opportunities. The research objectives include: Analyzing the current state of AI use in Algerian higher education includes studying current applications and assessing the level of technical and human readiness.

Forecasting future challenges and identifying possible opportunities: This aims to provide a comprehensive analysis of anticipated challenges and ways to overcome them, as well as exploring opportunities that can be exploited to improve the quality of education.

Proposing strategies and recommendations to enhance AI use in education: Providing implementable strategies and recommendations based on best global practices and successful experiences.

Based on the above, we can pose the following main question: **How can AI contribute to the development of higher education in Algeria?** This central question branches into several sub-questions:

- What are the main challenges facing AI applications in Algerian higher education?
- What opportunities are available to improve the quality of higher education through AI?
- What are the effective strategies for integrating AI into educational curricula?

The motivations for this research stem from the urgent need to develop higher education in Algeria and utilize modern technology to improve the quality of education. AI is a powerful tool that can fundamentally change teaching and learning methods, contributing to preparing students for the constantly changing labor market requirements. Additionally, the research can help bridge the knowledge gap regarding AI applications in the Algerian context and provide a theoretical framework that supports future initiatives.

This research provides a theoretical framework that can serve as a reference for academics and decision-makers in Algeria. By analyzing challenges and opportunities and offering recommendations based on scientific research, this study can support efforts to integrate AI into higher education and achieve a distinguished and sustainable educational experience.

2. Background and Significance

2.1.1. Historical Overview Higher education in Algeria has a colonial heritage, with the University of Algiers founded in 1909. After the outbreak of the Algerian war in 1954, the French colonial government further developed higher education to train local Algerian personnel. Also, the Arabization policy was initiated. After the independence of Algeria in 1962, primary and secondary education began to expand rapidly, while the higher education system still maintained the colonial system constructed by the French. The higher education system in Algeria consists of universities, central schools, higher schools, and national institutes since 1965.

2.1.2. Status Quo and Call for Modernization

Algeria currently owns 80 universities and 108 colleges, and every one of the 48 provinces has at least one university. There are 1.6 million students at the university level. In addition, it accounts for 70 percent of the country's scientific research funding. This analysis shows they are at a bursting point in the higher education bubble. For example, about 100,000 students per year obtain a baccalaureate or equivalent certificate nationwide, and the university finally recruited about 30,000 new students only. There is an urgent call for the modernization of higher education, diversifying course contents, and introducing innovation. (*Mallik & Gangopadhyay, 2023p.11*).

1.1.3. Importance of Applying AI to Education

This urgency has increased interest in applying artificial intelligence (AI) in education. AI applications in education are expected to improve significantly the effectiveness, quality, and accessibility of the educational process. Quality education has been recognized as key to sustainable and inclusive growth of the nation, which is why it has been incorporated into its Sustainable Development Goal 2030. Significant disparities exist between the capital, Algiers, and the other provinces regarding educational quality and basic material conditions. Besides, as the first language of education in Algeria changed from French to Arabic, dropouts from school have significantly increased, especially in rural areas. Meanwhile, the introduction of AI technologies in education has gained increasing importance in recent years. There is ongoing research and development worldwide on how AI in education can better prepare a new workforce for whom lifelong learning is a must and generate new equity in education (*Mallik & Gangopadhyay, 2023p.13*).

2.1.4. Impacts of AI in Education in Algeria

This analysis first defines the potential and status quo of Algerian higher education, proposes why applying AI to education is significant, and then presents the background of AI in education, issues, and trends. It then highlights applying AI methods, tools, and technologies to several areas in higher education before exploring the impact and challenges of using AI in Algerian tertiary education. Finally, critical success factors for AI-driven education are discussed.

3. Artificial Intelligence in Higher Education

Artificial Intelligence (AI) is expected to have transformative effects on higher education shortly due to the growing importance of a knowledge-based economy (*Shaik et al., 2023p.8*). This chapter provides a comprehensive look at the role of AI in educational settings. It begins by defining artificial intelligence and the facets of AI technology relevant to educational contexts. An overview of different AI technologies relevant to

the education domain, including machine-learning techniques and Natural Language Processing (NLP). The technological implications concerning integrating these technologies into teaching and learning environments are detailed, and there is a need to adapt these solutions to meet specific educational requirements. A selection of global practical examples from educational contexts illustrates these analyses before an in-depth examination of their implications for educational practices in Algeria. Artificial Intelligence (AI) is a general term for various computational methodologies capable of mimicking certain functions of the human mind, such as learning and problem-solving. AI systems use algorithms to process data through functions like prediction and classification. Several technological facets of AI are relevant to educational applications. The focus here is on advanced data-analysis technologies, including machine-learning methods and the interpretation of natural language, as implemented in applications of student feedback analysis. Machine Learning (ML) technologies are currently of the most interest within education because they have the potential to provide easily-integrated predictive and classification functions. Pre-processing, such as data cleaning and reduction, is systematically implemented before mining starts. Predictive ML programs use training datasets to produce models that best fit the needed output considering the input data. There are different types of predictive models, and the number of target variables can possibly categorize them. Classification ML algorithms develop models capable of distinguishing different categories, the values of the desired output being categorical. Regression ML tools, by contrast, predict continuous target values. ML can be exploited to enhance the personalized experience of students within virtual learning environments. For instance, a platform adjusting to the needs of a specific student can be implemented, including providing resources to scaffold learning, feedback on learning activities, or adaptive tasks. Educational AI tools should be developed considering specific learning needs and existing infrastructures.

The global economy has undergone substantial transformations in recent decades, increasing competition and changing market demands. Societal changes have required massive adjustments in the education sector, including the advantages of artificial intelligence (AI) for education delivery and lifelong learning. Applications of AI tools for the education sector in different international regions are used for benchmarking with the Algerian context, outlining potential benefits, and discussing smooth implementation. The relatively substantial growth and extended internationalization of the higher education sector worldwide can be interpreted by the fact that

education is increasingly a key factor in economic development. Active participation within the global economy requires a highly skilled workforce based on a solid educational background. Moreover, educational research is becoming increasingly important because the quality of teaching directly affects students' ability to prosper in an ever-evolving world. Higher education is currently being internationalized to address issues of cross-border education and the formulation of university associations. At the same time, the Internet has possibly revolutionized traditional educational delivery. (*Shaik et al., 2023p.10*)

3.1. Definition and Overview

Artificial Intelligence has been the focus of attention in the past few years, and many researchers have given varying definitions due to its broadness and ambiguity. In the context of this text, from an educational perspective, AI is defined as an analytical system and a technology capable of mimicking human cognition to evaluate complex and unstructured information in educational data. This definition is utilized throughout the text. Various recognized academics and experts provide a comprehensive overview of artificial intelligence, indicating that a solid basis is yet to be formed in the sector. It is essential to note some technical definitions and terminology to comprehend the relevant problems and educational application needs. Therefore, an overview of artificial intelligence is provided, and some fundamental concepts that aim to benefit an adaptive learning paradigm for a better understanding of higher education are emphasized. Artificial intelligence, its current state, application areas, and key components are discussed. This definition also covers human cognition aspects and AI operational modalities that offer a broad perspective on understanding and managing AI. Concepts and technological background are summarised as crucial for education and other sectors. (*Shaik et al., 2023p.14*)

Effective and efficient assessment is commonplace in artificial intelligence applications. However, using only human resources, accuracy, and operational speed are difficult and expensive. The purpose and necessity of developing automated systems have been mentioned. It is also important to mention that implementing such systems is non-trivial without a comprehensive understanding of AI components, technologies, and request procedures. This highlights the importance of discipline. It is an academic and applied area concerned with comprehension, analysis, and design of computational problem-solving models and systems beyond the human demand analysis and thinking distinctive phenomena. Active research and formal directions are oriented toward this endeavor. It has a profound, wide,

and multilateral interface with other disciplines and changes many research, social, industrial, and economic systems, processes, methodologies, and services through automation.

3.2. Current Applications

As AI has been subsumed into everyday life, the role of artificial intelligence (hereinafter AI) in education and how it can be addressed practically is increasingly being discussed. AI is already actively employed in an area directly affecting national advancement and individual welfare: higher education (**R. Kshirsagar et al., 2022p.43**). There are plenty of proven cases of AI applications that improve educational efficiency, from AI tutors helping students with well-differentiated instruction to predictive analyses that boost student success; moreover, there are also numerous cases of increased efficiency through automation in administrative aspects of higher education institutions. Currently, cases of AI application in higher education institutions are broadly presented. These cases are also studied from a practical angle, such as which educational need or problem they are addressing and which product they are using. Through the study of practical cases, what success or failure can be achieved with the current level of AI applications in the national education environment is investigated. The applications thus found are also significant in directly assessing the factors of educational and technological friendship that may help AI education. At the same time, in developing policies to foster advanced training of teachers, some points lead to the direction of education-integrated use of recent AI tools. The educational environment and technology infrastructure in some developed countries that lead the global AI revolution are spreading from selected examples of worldwide success stories, with consideration of what can be learned or applied in the domestic context to close the gap.

On the other hand, less or less successful cases provide the opportunity to understand the difficulties faced when implementing AI in education. However, each of the above should not be interpreted as an evaluation of success or failure in absolute terms; they can be seen and considered as relatively successful ways that have worked to some extent in a particular context or less successful ways that have failed to be applied extensively or have had no effect. (**R. Kshirsagar et al., 2022p.45**).

4. Potential Benefits of AI in Higher Education

1. Artificial intelligence (AI) has the potential to impact higher education in numerous ways. A comprehensive educational experience with tailored learning paths can be obtained with the help of AI personalized learning. Through AI, students can learn better, generally showing better performance when an AI tutor is present (**Hemachandran et al., 2022 p.22**).

Additionally, having AI tutors ensures that learning takes place at each student's individual pace. This can be ensured by permitting a student to repeat a task multiple times. AI can generate natural facial expressions, spoken dialogues, and body gestures. When a student is attended to by AI tutors that can produce these emotions, the student is more likely to delve into the subject matter. AI can be methodically computed according to the student's needs and knowledge. An AI tutor helps a student by identifying and focusing on understanding essentials a student is unfamiliar with while skipping less crucial topics. When humans emulate AI tutors, the student often underlines the less vital material. In this setup, the vital material is intentionally overlooked, and the student is not benefited.

2. As intimated by the architects of the Malthusian and the Solow models, students at the university level pursue higher education to gain knowledge, but, in actual circumstances, they pursue it to increase their productivity and wages in the job market. If a country faces a more significant number of job vacancies, firstly, the mentors would attempt to decrease the aggregate labor supply by deterring individuals from pursuing higher education in more significant numbers. This, in turn, diminishes the growth of knowledge and, therefore, wages in the long run. Moreover, to stop other low-income countries from reaping the benefit, the developed nations impose strict restrictions on importing rare and high-tech products and super-talented labor, thereby compelling the labor and the government of the medium-income and low-income nations to obtain fewer benefits. Thirdly, if the government imposes tariffs on these items only, then the prices of the non-favorable trade products would shoot up, causing a rise in the students' living costs. This factor would play a role in stopping the students from pursuing higher education to a certain extent. (*Hemachandran et al., 2022 p.25*).

4.1. Enhanced Personalization and Customization

According to recent estimates, Algeria ranks as one of the globe's lowest English-speaking countries, with an adaptive platform utilization rate of 4.3 percent. This "Adaptation Rate" defines the proportion of actively-learned users who have chosen personalized learning paths. The Algerian education system encompasses three key stages: primary, secondary, and tertiary levels. This focuses on the higher education sector as a qualification prerequisite for postgraduate study and professional practice. Institutions of higher learning, indicating universities beyond their academic discipline and operations, are the focal points. Technical aspects are illustrated. Sociocultural aspects are embedded in the details. Major stakeholders involve students, teachers, and supporting staff, including teaching

assistants and clerical workers and administrators. (*Hemachandran et al., 2022 p.27*).

In a broader worldwide context, personalized learning can be traced back to the 1950s. Advantages of "Adaptive Learning" include, but are not limited to, ensuring the provision of relevant educational content to students; improving student performance by ensuring understanding; reducing the risk of dropping or failing out because of academic incapacity; and statistically estimating student performance utilizing insights to present compounded academic support. Recent artificial intelligence (AI) developments, such as progress-enhancing economics, innovation, nation-building, science, transdisciplinary mathematics, and the technosphere, have opened up broad opportunities for the global community. AI technologies in higher education foster personalized learning, enable processing vast data through workflows and dashboards, improve resource utilization, and help stakeholders by delivering timely guidance through recommendation systems.

5. Challenges in Implementing AI in Algerian Higher Education

Algerian higher education institutions are situated within a society with limited AI resources and technology, falling behind in implementing AI in teaching, grading, and tutoring tasks. Indispensable AI technology, like cloud-based computational services that can handle significant data, consists of an array of processor units and other components that can distribute the computational cost. Such technologies were not adopted, and implantation shortly, with the current state of the economy and AI technology worldwide, does not seem to be on a fast track. Two main additional lackings in the system also contribute to resource scarcity: (a) the missing easy-to-access and uniform student information systems and (b) the lack of an organized and paperless system of university libraries (*Katsamakos et al., 2024p.19*). Another challenge faced is the hesitation of most academics, professors, and faculty members to involve AI in their tasks. Their indifference is due to their lack of knowledge about the high potential of AI implementation in their sector. AI is often, therefore, overlooked as a mere product of computer science. Additionally, a high percentage of older faculty members have a prejudiced view about merging an innovative and modern system like AI with their life-long-experienced and academic performing sector, as they think higher education methodologies worked perfectly in the past and still show no indication of decline.

It is noted that the pace of wider AI implementation in international higher education institutions is also heavily influenced by resistance on the part of the academic staff. There exist a set of significant obstacles within the

academic community of an institution that hamper successful AI implementation. Such challenges include a fear of losing power, fear of losing a job position, overwhelming work overload from having to deal with unfamiliar tools, reluctance to modify the established routine, academic autonomy, and credibility issues between colleges since a more tech-savvy individual would have an advantage. (*Katsamakos et al., 2024p.21*).

5.1. Infrastructure and Resource Limitations

Human activities will benefit and be impacted by integrating AI or AI-enabled technologies. It has already been implemented in various sectors, like medicine and agriculture (*Mallik & Gangopadhyay, 2023, p.28*). The education sector is no exception to that. AI can enhance teaching and learning processes in the educational sector at all levels, even in higher education. Due to that, it is expected that the education sector, significantly higher education providers, will prepare to adapt or even adopt AI as a part of educational activities. Recently, the Algerian government put an effort to improve their higher education in terms of policy and financial strategies. However, implementing AI in higher education in Algeria will need continuous monitoring to realize its full potential. This chapter will discuss the infrastructure and resource limitations facing the implementation of AI in Algerian higher education.

The current capabilities of the technological infrastructure in educational institutions are insufficient to implement AI in educational activities effectively. The condition of public infrastructures in Algeria is much worse, impacting the quality of public services and the education sector. The educational system in Algeria utilizes an outdated model, and there is a lack of equipment. Improvements to technological equipment started in the early 2010s, but the lack of sufficient funds had affected the coverage of consumer's needs, even though they were already behind Europe. Moreover, the success of building the new infrastructure was not achieved by providing the maintenance process. Problems with labs, microcomputers, power plants, and other tools impede the organization of practical work.

In remote areas, even though some schools have already been built and have all the needed facilities, internet access seems complicated due to the lack of the necessary technological infrastructure. This study shows that, at best, not more than half of students in high schools enjoy wireless connectivity, mainly due to the lack of smartphone ownership. Before the COVID-19 crisis, to fill the gap in internet access, the government implemented the Oasis project in two thousand high-access internet deficit schools across the country through eco-friendly solar-powered stations. It was foreseen that

6,000 high schools would benefit from the project, but only 1500 schools can take part in it by March 2020. (*Katsamakas et al., 2024p.27*).

Thus, in general, the access to necessary software has also been difficult to be installed due to the lack of the necessary infrastructure. In order to utilize the AI technologies and benefit from the involvement in the fourth industrial revolution as well, it is almost imperative to allocate a significant importance to building a robust technological infrastructure in the educational institutions as well as in the country. Public-private partnerships are encouraged to overcome this gap. Investment in research, scholarships, and industry engagement are recommended for academia. At the same time, the government also needs to invest in developing an AI lab, supercomputing, and scientific network and partake in forming an AI zone and tech valley.

6. Ethical and Societal Implications of AI in Higher Education

Artificial intelligence (AI) presents exciting new opportunities for higher education regarding formative feedback, adaptive learning analytics, and intelligent tutoring systems. However, serious ethical and societal challenges remain. AI systems depend on the availability of educational data, and such dependencies involve potential risks. It is essential to develop ethical guidelines that optimize the utility of this data while safeguarding issues of privacy and informed consent. There is growing concern that AI will embed and reinforce existing bias, exacerbating inequalities in educational assessments and outcomes. To maintain trust, it is necessary to make AI systems transparent to students, teachers, and educationalists. Concerns are also raised about the potential societal impacts of educational AI and the potential for new inequalities in student access to these technologies.

There is now an extensive list of AI technologies being developed and adopted in education, with some suggestions that AI in the educational sector will be worth an estimated \$6 billion by 2025. (*Katsamakas et al., 2024p.21*). Some argue that incorporating AI into education will help better connect students and instructors while using the wealth of data from online learning platforms. In so doing, AI in education could help enable more 'personalized learning plans and virtual advisors'. For higher education, significant financial investments are being made in AI technologies that have the potential to 'boost graduation rates (while) reducing the resources needed for students'. It is argued that the deployment of 'Predictive Learning Analytics' systems in higher education has the potential to raise the course pass rates by more than 40% (*Nguyen et al., 2023 p 41*).

6.1. Data Privacy and Security Concerns

In the context of the emergence of Artificial Intelligence (AI) in higher education, the efficient use of various facets of this technology has still prompted several technical, organizational, and even legal questions. Specific attention has to be given to data privacy and security, mainly those intrinsic to the nature of AI when data are sensitive and delicate. Among diverse strategies devised to answer such challenges, the most current method consists of anonymity or even pseudonymity, which involves disguising the data that plays a key role in learning. As for data privacy and, more generally, security concerns, which are completely tied up, the use of AI in higher education constitutes a wealth of new opportunities but also many possible sources of risk and actions to hedge them (**Lakkaraju et al., 2024, p.5**). Indeed, this raises substantial data integrity and confidentiality issues pertaining, for instance, to personal or exam pieces of information. Without aiming to be exhaustive, the purpose here is somewhat (and at first hand) to conceive how AI may turn delicate or even critical in higher education.

Muffins, when AI rhymes with IT. In practice, dealing with similar situations has become a standard data processing pattern; there is no exception in higher education contexts. We are not ready to automate anything just by integrity enforcement with no external control device. The most differing point between data management in a case study like this and usual approaches is probably resistance to implementing automated lifting rules. Patrons here linger in irreducible learning matters. Still, it should be noted that inspecting an extensive collection of free texts arrayed over a long period would remain a tedious task without any automated help (**Latham & Goltz, 2019, p. 35**).

7. Conclusion

This study will analyze the current state of AI in education and its prospects in the field of learning. It will underline the current beneficial elements and look into the challenges the implementation of AI entails in Algeria's educational system. For developing countries, the sudden adoption of advanced technology implies serious infrastructural drawbacks. This is the case with Algeria. Higher education in Algeria is already facing a huge budget deficit, combined with a lack of trainers and researchers. The technicality of AI makes adapted teaching compulsory with continuous updates. The need for continuous investment diminishes beneficial aspects of AI, such as the productivity of managed resources. It is, therefore, a long and costly investment path that the Algerian government must consider. Applying AI in education also implies sufficient digital devices and broadband internet connection. This is not yet the case for all educational

facilities, which include, aside from higher schools and universities, teaching colleges, which are managed by the province directorates. Academic staffs of Algerian universities have not been all initiated to the benefits of AI and even more practically did not benefit from exposure to the technology. Thus, there is still a long path towards the adoption of AI for training and research in the Algerian university system. Not only are the financial obstacles to be surpassed, but it is especially necessary to continuously educate trainers who will, in turn, educate students and deepen their adaptation to the increasing technology shift.

Another challenge to consider when introducing AI into Algerian education is, as mentioned before that some people do not have access to basic education and do not know how to read and write. The rapid introduction of AI can widen the gap between these categories of the population and those who have the means to benefit from this technology. Thus, Clarified programs need to be planned to support those far from formal education, not deprive them of a profitable aspect of AI while supporting the not-to-be-brutal introduction of the technology. The introduction of AI in education thus needs to adhere to the existing pedagogic strategy and not force an unprepared passage to a new edifying approach. It also highly relies on the targeted groups of learners, who must meet a minimum of technological and educational prerequisites. The Algerian primary objective, set in March 2004, is to fight illiteracy and give all Algerian citizens access to the knowledge and information that is the base of any development. Efforts have been made, and more than five million citizens, mostly women, have benefited from this effort. There is, however, still a large share of people throughout the country looking forward to sharing this elemental education. The fast implementation of AI material could, on the other hand, counterbalance the visible beneficial effect of this program and contribute to its eventual deceleration. The introduction of ICT in Algerian elementary schools has already demonstrated some problems and has yet to prove its efficiency. The urgent need for AI uses in the Algerian academic fields is undoubtedly justified. However, the investigation of the complete scenario, as led in this contribution, leads to the prerequisites that cannot be overlooked and need to be respected for the implementation of AI in the Algerian educational systems to be optimum.

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