

## Developing Next-Generation Skills for Data Professionals in the Era of AI: A Roadmap for Nigerian Universities

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**ABSTRACT:** Nigerian universities are not able to prepare graduates of data science who will be able to meet the requirements of an AI-driven economy, as they continue to encounter various problems. Lack of curriculum content, shortage of faculty knowledge in the field of AI, poor digital infrastructure, and weak university-industry partnerships are among the factors that have led to widening skills deficits in Nigerian universities. This research, through a convergent mixed-methods approach, including a bibliometric review, survey, and expert panel, charts a strategic roadmap for strengthening AI and data science education in Nigeria. The survey, expert validation panel, and bibliometric review of 48 Scopus-indexed publications (2020-2025) informed the study, which used a convergent mixed-methods approach integrating all these sources of data. The results point out that in AI ethical principles only 13% of the institutions have modules, 66% of the faculty feel that they have low competence in responsible AI practices, and only less than one-fourth of the institutions have active partnerships with the industry. The Content Validity Index (CVI = 0.82) was used in validating the relevance of the proposed four-pillar roadmap—curriculum modernization, faculty development, industry collaboration, and infrastructure investment. The study indicates that it is necessary to carry out reforms at the targeted system-wide level to be able to nurture AI talents who can compete on a global scale and to make Nigeria a country that can engage in the data-driven economy in a meaningful way.

**KEYWORDS:** AI Education, Data Science Curriculum, Nigerian Higher Education, Workforce Development, Skills Gap, Industry Partnerships, Ethical AI

### I. INTRODUCTION

Artificial intelligence (AI), data science, and automation are radically changing global labor markets in a way that is comparable to the previous industrial revolutions. In all sectors - finance, health, agriculture, education, and public administration - companies require professionals to perform the following tasks: deploy machine learning models, interpret the large-scale datasets and incorporate ethical AI practices into the decision-making systems [1]. Countries that have a robust higher education system have reacted by redesigning the curricula, investing in the development of the staff and creating a training program which is in line with the emerging global competency frameworks. The situation is quite different in numerous developing countries, such as Nigeria, where a large number of graduates remain unqualified for the rapidly changing skill demands due to the systemic challenges [2]. Despite Nigeria's ambitious and bold national digital transformation projects, such as the National Digital Economy Policy and Strategy (NDEPS) and the 3MTT program, universities are still struggling with the following problems: curricula that have not been updated, a lack of specialized faculty, limited cloud-ready infrastructure, and weak industry linkages [3]. Various reports have recognized these problems, however, most of the research is still fragmented and only looks at isolated curriculum reviews, anecdotal assessments, or narrow technical skills. What has been

overlooked is a comprehensive and data-driven study that combines curriculum content, faculty expertise, infrastructural readiness, and conformity with the recognized global frameworks such as the EDISON Data Science Framework (EDSF), Competency-Based Education (CBE), and UNESCO's Responsible AI Competency Framework [4]. The study fills a gap through a comprehensive mixed-methods evaluation that comprises a bibliometric analysis, surveys of 15 Nigerian universities (N=1,050), and expert validation. Combining these various sources of data reveals the interplay of factors at the structural, educational, and capacity levels that determine the rise of AI and data science proficiency in the Nigerian higher education system. The first objective of the study is beyond the mere finding of the deficit; it aims to become a means of institutional change and national labor market competitiveness by effectively conveying the roadmap.

With these goals in mind, the research revolves around the following questions:

- (a). RQ1: To what extent is there introduced key AI and data science curricular contents in Nigerian Universities?
- (b). RQ2: Which competencies of faculty members who teach AI and data science courses are lacking?
- (c). RQ3: To what extent university curricula currently in place correspond to global frameworks such as CBE, EDSF, and UNESCO's Responsible AI Competency Framework?
- (d). RQ4: What institutional impediments, that is infrastructure, faculty capacity, industry partnerships, and ethical AI integration-related problems, are responsible for the lack of effective utilization of AI and data science education?
- (e). RQ5: Which data-driven roadmap would help Nigerian universities in the task of educating the next generation of the workforce with data science and AI skills of the future?

Through the answers to these inquiries, the research provides a solid empirical basis for national policy, curriculum reform, and strategic investments that would enable Nigeria to take a meaningful part in the worldwide AI-driven economy.

## II. RELATED WORKS

Research in AI and data science education has been vibrant over the last ten years. The demand for graduates who are well-equipped to work in complex and data-intensive environments is the major driver of this research. The published works can be seen as three interrelated themes: (1) worldwide changes in AI and data science skill needs, (2) changes in the curriculum and the setting of pupils' learning goals, and (3) the preparedness of tutors and the shortage of facilities in the third world. These pieces of literature are like the outer rings of a bigger circle which forms a perfect background to comprehend the current state of Nigeria and the gradual systemic changes required to close the gap of skills [5].

### A. Global Evolution of AI and Data Science Skill Requirements

Several global studies illustrate that the trick is to change the competencies required almost overnight for AI-driven work environments. Earlier workforce models heavily emphasized that the workers should be proficient in programming, statistics, and data management, whereas now the models give first place to ethical AI literacy, accountable innovation, cloud-native workflows, machine learning model interpretability, and interdisciplinary problem-solving [6]. In their report, the World Economic Forum, OECD, and UNESCO elaborate that most newly-created roles in AI require skills such as model governance, transparency, fairness, and real-time data engineering to be done at a very high-level, which are skills that are hardly found in university programs even in the Global South. For example, Singapore, Canada, and the UK have redirected their education systems by overhauling of the syllabi to meet industry demands.

They manage to do this by infusing the industrially-relevant modules, micro-credentials and domain-specific AI training in the curricula. These worldwide trends set the standards for local educational contexts including that of Nigeria so as to be capable of gauging their preparedness [7].

### **B. Data Science Education Models and Curriculum Design Frameworks**

Numerous publications have shed light on the models of structuring AI and data science education that eventually lead to comprehensive curriculum designs. Accountable frameworks like Competency-Based Education (CBE), the EDISON Data Science Framework (EDSF), and the UNESCO Responsible AI Competency Framework provide a structured way to the school leaders to organize their syllabi while stressing the importance of measurable outcomes, the ethical aspects, and the inclusion of different subject areas [8]. Research adopting CBE approach to education draws attention to the usefulness of the alignment of instructional objectives with observable skills, especially in applied machine learning and data engineering. Scholarly works fueled by EDSF advocate for data governance, cloud infrastructures, lifecycle management, and professional skills, whereas the framework by UNESCO supports the fair, human-friendly, and inclusive AI practices. At the same time, comparative studies expose significant differences between these global standards and actual educational programs in the developing world, where syllabi are rarely updated and are heavily dependent on outdated computing content with little or no exposure to recent AI workflows [9].

### **C. Faculty Readiness and Institutional Capacity Gaps**

Teachers' skill in the subject matter is known as a very influential factor which determines the standard of program content quality in AI and data science. The surveys done in Africa, Asia, and Latin America report that there is a shortage of instructors who possess the necessary skills in areas like deep learning, cloud computing, responsible AI, and scalable data processing, and this is a common trend in all these continents [10]. Moreover, faculty members usually are not given the proper training even if the syllabi are changed to make them capable of delivering the new content effectively. The difference between the level of curriculum ambition and that of the faculty's skill set causes those implementation bottlenecks which in turn slow down the pace of completing the job. Besides that, there are some infrastructural limitations such as poor computing resources, low internet speed, and non-availability of cloud platforms that hamper hands-on teaching and learning through projects. Comparative research findings from India, Rwanda, and Egypt reveal that continuous investments in faculty training and technology collaborations can greatly speed up a country's journey towards AI teaching excellence, thereby pointing out the possible directions for Nigeria [11].

### **D. AI Education in Africa and Nigeria's Emerging Landscape**

The African AI education ecosystem is still not balanced and is mainly characterized by these factors: scattered innovative areas and deep systemic barriers. Research conducted in Ghana, Kenya, and South Africa discover the problems very similar to those of Nigeria, which are also characterized by outdated syllabi, little use of ethics and lack of industry collaboration. Studies that focus on Nigeria signal the demand for AI talents in the market while highlighting the gaps that still exist between university training and the needs of the workforce. Nevertheless, the majority of the Nigerian research works are minuscule and mainly focus on one institution or narrow technical skills. There has been very little work done to combine evidence from curriculum analysis, faculty capacity, bibliometric trends, and expert validation. Hence, the existing body of research provides good insights but is not broad enough to guide the national policy and large-scale curriculum reform [12].

## **E. Theoretical and Conceptual Framework**

Theoretical support is a prerequisite for recognizing the systemic elements that impact the readiness of Nigerian universities to provide AI and data science education. The present study incorporates five interrelated theories—Human Capital Theory, the Technology Acceptance Model (TAM), Competency-Based Education (CBE), the EDISON Data Science Framework (EDSF), and UNESCO’s Responsible AI Competency Framework [13]. Individually, each of these theories covers one aspect only. However, if one looks at them comprehensively, they form a seamless conceptual whole that can help one understand curriculum design, faculty preparedness, institutional capacity, as well as the sociotechnical environment necessary for the training of data professionals of the future [14].

### **(a). Human Capital Theory**

Human Capital Theory assumes that one of the most pivotal functions of education is to develop the knowledge, skills, and abilities that are instrumental for national productivity and economic competitiveness. The theory, when situated in the context of AI and data science, emphasizes the importance of investments made in areas like faculty development, curriculum modernization, and technology infrastructure [15]. Countries where AI skills are regarded as national assets have been able to quickly transform their economies whereas those countries which have not invested enough in human capital—especially in areas of emerging technologies—are left with deepening digital and economic divides. Concerning Nigeria, this theory brings to light the fact that solving the problem of lack of skills in areas such as ethical AI, cloud computing, machine learning, and data governance should be of first priority. [16].

### **(b). Technology Acceptance Model (TAM)**

TAM sheds light on the behavioural aspects as well as the institutional factors that can facilitate or hamper the use of new technologies. When it comes to AI education, the model explains the reasons why students and faculty are sometimes resistant to, and sometimes welcoming of the new tools, platforms, and pedagogical approaches. Two factors, which are perceived usefulness and ease of use, have a great influence on the user's willingness to adopt technologies such as cloud-based environments, machine learning platforms, or ethics-focused AI toolkits. The situation that prevails in many Nigerian universities is such that constrained digital infrastructure, lack of training, and little exposure to state-of-the-art AI tools make acceptance and adoption very low, thus the delivery of advanced competencies is hindered [17].

### **(c). Competency-Based Education (CBE) Framework**

CBE focuses on verifiable educational outcomes as well as the mastery of practical skills that are in line with the industry. In AI and data science education, CBE brings the teaching to the level of the students' demonstrable competencies by making them capable of activities such as dataset management, model development, MLOps workflow, and ethical decision-making. Real-world cases serve as proof that CBE-based programs graduate students who more easily make a transition from academic to professional roles. Nevertheless, Nigerian curricula are still very much content-driven and, therefore, concentrate on theoretical instruction rather than the mastery of skills. CBE, therefore, opens the door to reforming the AI curriculum in a manner that is more practical, training in labs, and focused on the outcomes [18].

**(d). EDISON Data Science Framework (EDSF)**

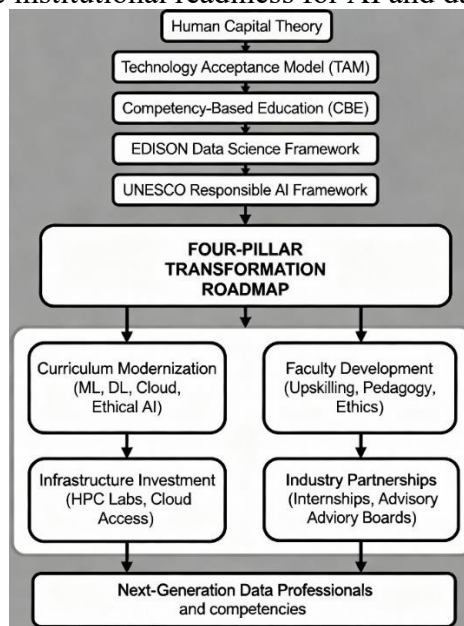
EDSF offers a comprehensive model for defining the skills, knowledge areas, and professional behaviours required for data practitioners. It identifies core domains such as data governance, cloud-based infrastructures, lifecycle management, business understanding, and professional ethics. Comparing Nigerian curricula with EDSF reveals significant gaps—particularly in cloud computing, scalable data engineering, and ethical AI practices. EDSF therefore serves as a benchmarking tool for evaluating curriculum alignment (RQ3) and informing the roadmap proposed in this study [19].

**(e). UNESCO Responsible AI Competency Framework**

UNESCO’s framework introduces competencies related to fairness, transparency, accountability, inclusiveness, and societal impact of AI systems. As global institutions increasingly integrate responsible innovation into AI curricula, ethical AI literacy has become a foundational requirement for AI professionals. Nigerian curricula, however, dedicate minimal attention to ethical or trustworthy AI, resulting in notable faculty and student competency gaps. Integrating this framework provides a normative foundation for embedding responsible AI principles within national educational strategies [20].

**(f). Integrated Conceptual Model**

Drawing these frameworks together, the conceptual model (Figure 1) illustrates how human capital development, technology adoption behaviours, competency-based pedagogy, global data science standards, and responsible AI principles intersect to shape institutional readiness. The model theorizes that curriculum quality, faculty expertise, infrastructural adequacy, and ethical AI integration collectively influence a university’s ability to deliver next-generation AI and data science training [21]. This integrated model directly informs the research questions and guides the interpretation of empirical findings presented in subsequent sections. As illustrated in Figure 1, the conceptual model integrates the five theoretical frameworks to explain how systemic gaps in curriculum, faculty capacity, infrastructure, and ethical AI alignment collectively shape institutional readiness for AI and data science education [22].



**Figure 1:** Conceptual Model Showing Factors Influencing AI and Data Science Readiness in Nigerian Universities.

This theoretical grounding ensures that the roadmap is academically rigorous, internationally relevant, and contextually suited to Nigeria's higher education system.

## F. Summary and Identified Gap

Across the literature, a clear pattern emerges: global AI education is evolving rapidly, guided by competency frameworks and industry-aligned skill models, whereas higher-education systems in many developing countries remain constrained by faculty shortages, outdated curricula, and infrastructural limitations. While previous African and Nigerian studies have identified elements of these challenges, none have integrated bibliometric evidence, cross-institutional surveys, curriculum diagnostics, and expert evaluations into a unified analysis. This study addresses that gap by providing a holistic, data-driven assessment of Nigeria's AI and data science education ecosystem and proposing an evidence-based roadmap that aligns national capacity with global standards.

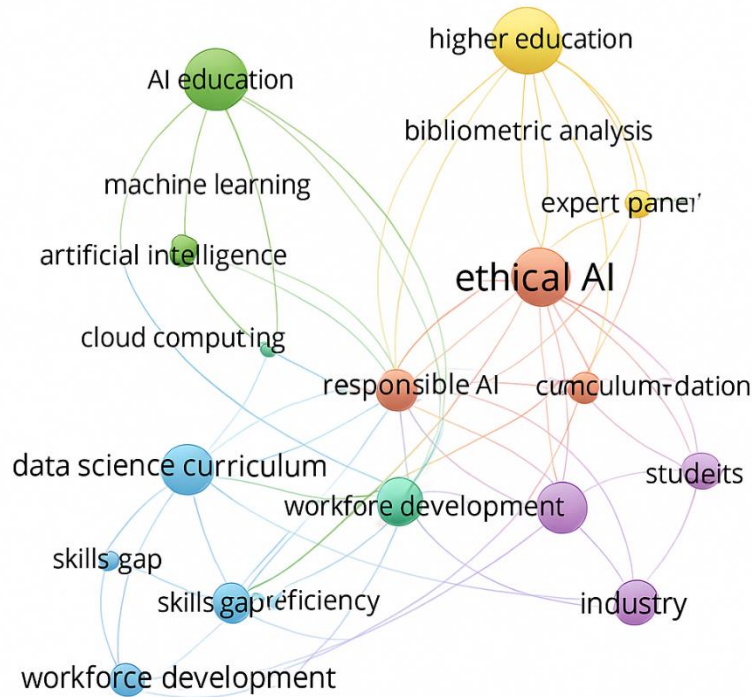
## III. METHODOLOGY

### A. Research Design and Paradigm

Introducing a convergent mixed-methods design, this study mixes quantitative survey data with qualitative contributions from an expert panel and bibliometric analysis. By using mixed methods, the researchers have achieved a remarkable level of effectiveness in the field of educational research, where this method was used to disentangle complex phenomena that require a different level of understanding. By referring to Creswell and Plano Clark, the authors outlined the procedure of this research as one that involves collecting and analyzing quantitative and qualitative data in a rigorous manner, hence, a comprehensive insight can be provided into complex educational phenomena. In the convergent design data, both quantitative and qualitative data can be collected at the same time and the integration of the two types of data occurs during the analysis and interpretation phases. Therefore, triangulation and validation of findings become possible.

Our study implemented a thorough bibliometric analysis of 48 influential Scopus-indexed articles published between 2020 and 2025. The topics covered were data science education, AI skill development, curriculum frameworks, and faculty preparation. The bibliometric method resorted to VOSviewer software for co-occurrence keyword mapping and topic clustering to facilitate thematic angle identification and future research pathways in the literature. VOSviewer, a text mining and network visualization tool, facilitates the systematic identification of knowledge structures, emerging research frontiers, and conceptual relationships within bibliographic datasets. Papers were chosen based on the following criteria: peer-reviewed journal articles from the top Scopus-indexed venues (Q1 and Q2 rankings), the date of publication within the given timeframe, and an explicit focus on data science or AI education at the tertiary level. The bibliometric analysis led to the identification of the five major thematic clusters: (1) curriculum architecture and program design; (2) faculty competency development; (3) ethical AI and responsible innovation frameworks; (4) industry-university collaborative models; and (5) infrastructure and technological enablement.

Figure 2 illustrates the bibliometric mapping derived from the literature indexed by Scopus, outlining the five chief thematic clusters, and thereby, the worldwide focus on curriculum design, ethical AI, faculty development, and institutional capacity building.



**Figure 2:** Bibliometric Map of Keyword Co-Occurrence Showing Thematic Clusters in Data Science and AI Education (2020–2025)

**B. Survey Design and Data Collection**

The mixed-methods survey instrument was created by iterative expert review and piloting with 25 faculty respondents and was sent to three different stakeholder groups across fifteen Nigerian universities. The first group included 250 faculty members of computer science, data science, mathematics, and statistics departments who were chosen through stratified random sampling across institutions representing diverse geographic regions and university classifications (federal, state, and private institutions). The second group consisted of 760 undergraduate and postgraduate students who were actively enrolled in data science, computer science, and related technology programs and were recruited using purposive and convenience sampling methodologies. The third group comprised 40 industry practitioners and organizational leaders from technology companies, financial institutions, and data-driven organizations operating within Nigeria who were selected via network sampling and industry association referrals.

The survey questionnaires contained 35 items that assessed the competency levels of 17 key domains such as machine learning, deep learning, cloud computing, big data analytics, programming languages, statistical analysis, data visualization, ethics and governance, explainable AI, cybersecurity, soft skills, industry 4.0 concepts, and domain-specific applications. The participants rated the competency levels on five-point Likert scales (1=no competence; 5=expert proficiency) and also answered the open-ended questions related to the curriculum gaps, infrastructure needs, and professional development priorities. Data collection was done over a period of three months (March-May 2025) through online survey administration using Qualtrics. Informed consent was obtained from all participants, and ethical research protocols were strictly followed.

### C. Expert Panel Validation

Three well-defined expert panel workshops were organized to validate the elements of the proposed roadmap and also to check their contextualized appropriateness of the institutional settings of Nigeria. Expert panels constitute a well-known method of content validation and model confirmation, especially when the development of evidence-based interventions is involved that require stakeholder consensus and contextual grounding. The panels were composed of twelve participants including AI researchers from the top Nigerian universities (University of Lagos, Ahmadu Bello University, University of Nigeria), technology industry leaders with operations in Nigeria, government representatives from the Ministry of Education and Ministry of Communications and Digital Economy, and educational policy specialists. The workshops utilized the Content Validity Index (CVI) method, whereby the participants independently rated each roadmap component on relevance and applicability scales. The elements obtaining CVI ratings of 0.78 or more were retained in the final roadmap. With the consent of the participants, panel discussions were recorded, transcribed and then subjected to thematic analysis for identifying the areas of consensus and divergent perspectives.

### D. Qualitative Data Analysis

Qualitative information obtained from expert panel discussions as well as from the open-ended survey responses was analyzed by thematic analysis which is a flexible qualitative methodology that is especially appropriate for studying patterns in the provided rich textual data. Thematic analysis in educational research means the systematic stages of getting familiar with the data, generating the initial codes, combining the codes into possible themes, checking the themes against the whole dataset, and refining the theme definitions with theoretical backing. The initial coding was done by two independent researchers, the differences in the codes were systematically compared and through negotiation, the coding discrepancies were resolved thus the analytical reliability was enhanced. Thematic analysis was done with the help of ATLAS.ti qualitative data analysis software which was a tool for systematically managing the codes and developing themes.

### E. Quantitative Data Analysis

Information from the survey was examined through descriptive statistics, such as frequencies, percentages, means, and standard deviations, and also through inferential statistics. The size of skill gaps was figured out by subtracting the reported levels of competence from the proficiency standards set by the industry and thus, creating gap scores for each area of competence. One-way ANOVA was used to find if there were any significant differences in skill gaps between faculty disciplines, student cohorts, and geographic regions. Post-hoc comparisons with Bonferroni corrections for multiple comparisons were used to determine the exact differences. The level of statistical significance was set at  $\alpha=0.05$ , while effect sizes (eta-squared) were reported to indicate the real significance of the results.

## IV. RESULTS AND DISCUSSION

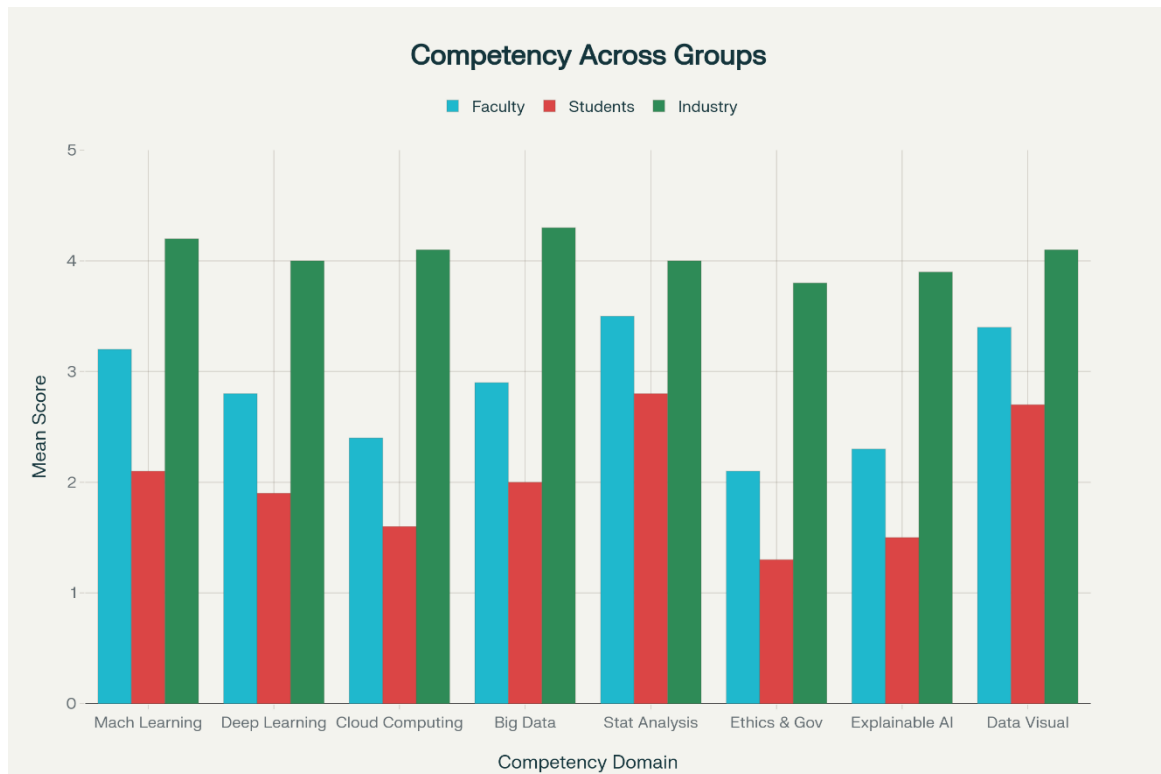
### A. Survey Response and Participant Demographics

This research was able to gather extensive data from a total of 1050 respondents from fifteen Nigerian universities. These universities represent federal (60%), state (25%), and private (15%) institutions, which are located in six different geopolitical zones. The university staff group consisted of 250 people (mean years of teaching experience: 8.3 years,  $SD=6.4$ ; 72% of them were master's or doctoral degree holders), 760 students (mean academic year: 2.4,  $SD=1.1$ ), and 40 industry practitioners from the top technology and financial organizations.

The response rates were 68% for faculty, 71% for students, and 85% for industry respondents, thus showing their considerable involvement in the research objectives.

### B. Competency Assessment Findings

The quantitative evaluation of the seventeen professional domains in which the subjects rated their competence revealed that the respondents have a considerable lack of skills, particularly in the newly developed AI specializations. On average, faculty members rated their proficiency in machine learning as 3.2 (SD=1.1) and in deep learning as 2.8 (SD=1.3) on a five-point scale, while industry practitioners gave the same ratings as 4.2 (SD=0.7) and 4.0 (SD=0.8), respectively. The difference of about one scale point between academic and industry practitioners implies a significant gap in the level of professional skills, thus indirectly indicating the quality of education and graduate competitiveness. In this respect, students' self-evaluation was even more striking, as their average scores were as low as 2.1 (SD=1.4) for machine learning and 1.9 (SD=1.3) for deep learning, which were far from the faculty and industry standards.



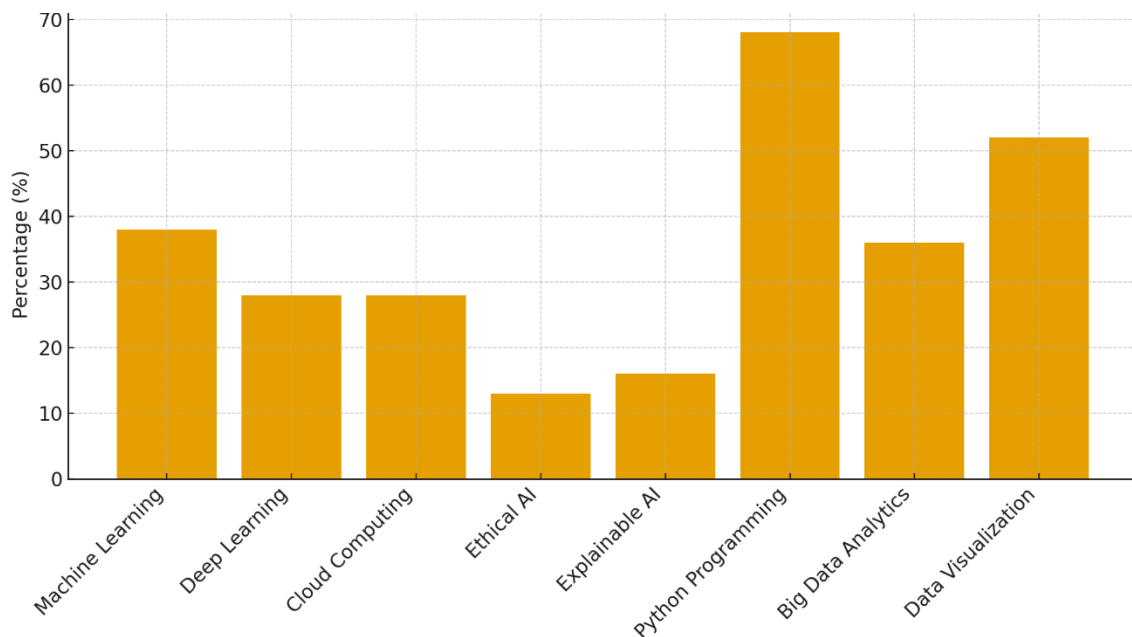
**Figure 3:** Mean proficiency levels across competency domains by stakeholder group (scale: 1-5, where 5=expert proficiency)

Most importantly, across all groups, ethical AI and governance frameworks showed the lowest level of competencies. Faculty reported average proficiency scores of 2.1 (SD=1.4) for ethics and governance competencies, with only 13% of the surveyed universities including a separate ethical AI module in the curriculum. Students averaged 1.3 (SD=0.9) on this dimension, which reflects the lack of basic exposure to topics like responsible AI governance, algorithmic fairness, bias mitigation, and AI ethics frameworks, which are indispensable for modern practice. The authors of the report point out the gap as particularly alarming, since it's internationally agreed that ethical reasoning and the use of AI in a responsible manner are two of the main professional skills.

Cloud computing and infrastructure made revealed a significant lack of skills that limited students' ability to carry out data science tasks in line with current standards. The mean faculty proficiency observed was 2.4 (SD=1.3), with only 28% of surveyed universities providing formal instruction in cloud platforms (AWS, Google Cloud, Azure). The industry practitioners, on the other hand, showed the average level of proficiency as high as 4.1 (SD=0.8), which is a testimony to the fact that cloud computing is at the core of modern data science infrastructure. This gap between curriculum and practice implies that graduates in Nigeria are not only facing a big challenge when it comes to getting a job in the field but also it will take them a long time before they can actually start working in cloud-dependent organizational settings.

### C. Curricular Coverage Analysis

An in-depth look at curriculum integration across the surveyed institutions revealed that the distribution of contemporary competencies was non-uniform. While traditional programming foundations (Python: 68%, R: 54%) were found to have the highest coverage, substantial proportions of programs still lacked formal instruction. On the other hand, the underpinnings of the future - the so-called 'emerging critical competencies' were, in fact, heavily exposed to serious risk thanks to their meager representation: explainable AI (16% curriculum coverage), ethical AI (13% coverage), and cloud computing (28% coverage). This trend suggests that curriculum modernization has largely been focused on strengthening basic skills while newer areas, which are becoming more and more demanded by employers and are also necessary for responsible AI deployment, have been overlooked. As illustrated in Figure 3, the distribution of curricular coverage shows that while preparatory competencies like Python programming and data visualization are generally covered, advanced areas such as ethical AI, explainable AI, and cloud computing are still far from being sufficiently addressed.



**Figure 3:** Curricular coverage of key AI and data science competencies across surveyed Nigerian universities.

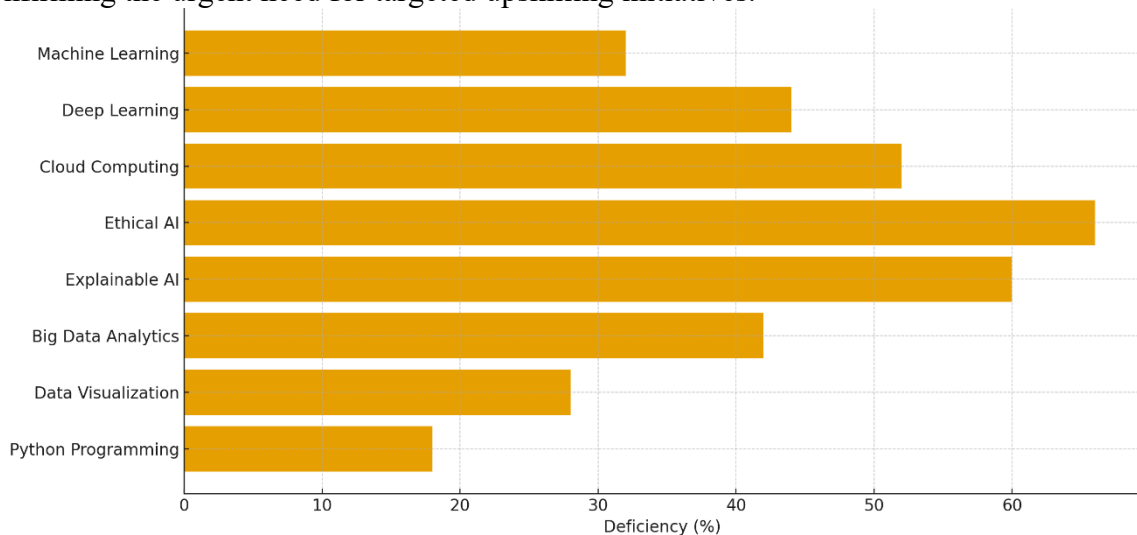
One-way ANOVA examining curriculum coverage across institution types (federal, state, private) revealed significant differences for machine learning ( $F(2,12)=4.31, p=0.038, \eta^2=0.42$ ) and ethical AI ( $F(2,12)=5.89, p=0.018, \eta^2=0.51$ ), with federal and private institutions demonstrating somewhat higher curricular integration of these domains. However, even

highest-coverage institutions incorporated these competencies in less than 50% of relevant programs, suggesting system-wide curriculum lag rather than isolated institutional deficiencies.

**Table 1:** Competency deficiencies and curricular coverage across surveyed Nigerian universities (N=15 institutions; 1,050 respondents)

Competency Domain	Faculty Deficiency (%)	Student Deficiency (%)	Industry Standard	Curriculum Coverage (%)
Machine Learning	32	58	4.2	38
Deep Learning	44	62	4.0	28
Cloud Computing	52	68	4.1	28
Ethical AI & Governance	66	74	3.8	13
Explainable AI (XAI)	60	70	3.9	16
Big Data Analytics	42	60	4.3	36
Data Visualization	28	18	4.1	52
Python Programming	18	28	4.4	68

Figure 4 further visualizes these gaps, demonstrating that faculty deficiencies are most pronounced in ethical AI, explainable AI, deep learning, and cloud-related competencies, confirming the urgent need for targeted upskilling initiatives.



**Figure 4:** Faculty competency deficiency gaps across major AI and data science domains relative to industry standards.

#### D. Infrastructure and Resource Gaps

An extensive qualitative evaluation through expert panel discussions and open-ended survey responses pinpointed the infrastructure as the main factor that severely limits the AI education

delivery that is able to meet the set standards. About 87% of the faculty participating in the study expressed that they have no or limited access to high-performance computing resources, modern GPU-equipped laboratory facilities, and cloud computing platforms for their instructional activities. Among the state-funded institutions, 92% of them were without AI research labs dedicated to research and fully equipped with modern computing infrastructure, whereas 68% of the private universities were in the same situation. It is these infrastructure pieces that directly put a ceiling on the supply of practical, hands-on experiential learning, which is the backbone of authentic data science competencies that are growing rapidly in demand.

As to the internet connectivity and digital infrastructure, they still pose formidable barriers to some extent, particularly to the institutions in rural and semi-urban regions. The expert panel members observed that roughly 56% of the universities surveyed suffered from unreliable internet connectivity that weakened their access to cloud-based learning platforms and remote collaborative tools. Restrictions like these are highly consequential as they limit the delivery of contemporary data science pedagogy that strongly depends on cloud access, open-source tool ecosystems, and online collaborative environments.

### **E. Faculty Professional Development Needs**

Faculty members who participated in the survey disclosed that 78% of them did not have machine learning pedagogical training, and 84% reported that they were not prepared to teach ethical AI and responsible AI governance. Besides that, 64% of the faculty poll respondents claimed that they had not been engaged in professional development activities that provide contemporary data science or AI methodologies in the past three years. The expert panel discussions that followed pinpointed this faculty capability void as the main factor hindering a shift to the new curriculum, and they further clarified that the successful execution of curriculum modernization depends on simultaneous faculty development system measures which include technical skill upgrading, pedagogical innovation, and industry practice awareness.

### **F. Industry-Academia Collaboration Status**

The evaluation of university-industry partnerships depicted a scenario of a paucity of formal mechanisms that facilitate collaboration. Merely 22% of programs that were surveyed disclosed that the presence of an industry advisory board was duly documented, which played a part in curriculum development, and only 18% had formal internship or apprenticeship partnerships with technology organizations. However, 95% of the industry practitioners are ready and willing to participate in curriculum advising and student mentorship initiatives. Hence, there is a huge volume of untapped potential for the collaborative skills development that is in line with the real needs of the workplace.

### **G. Expert Panel Validation Results**

The three workshops of the expert panel facilitated the validation of the proposed roadmap components, with an average Content Validity Index (CVI) score across the four strategic pillars of 0.82 (SD=0.09). All the panel members (100%) agreed on curriculum modernization and faculty development as being of the utmost importance. Most of those surveyed (92%) were in favor of the suggested infrastructure investment targets, while 83% of them agreed upon the formalized industry-university partnership mechanisms' necessity. The discussion among the panelists led to the formation of consensus about the urgency of ethical AI and responsible AI governance integration. To all of the panelists, these aspects are non-negotiable constituents of a contemporary data science education that they must emphasize most of all.

## DISCUSSION

The research highlights the preparedness of Nigerian universities for the next generation of AI and data science education. Among its findings are the enormous gaps in the coverage of the curriculum, faculty expertise, university facilities, and the alignment with the global competency frameworks. Altogether, these indicate a fundamental structural mismatch between the higher education system in Nigeria and the digital workforce of the world. The current section explores the findings in relation to the research questions and compares them to existing scholarship.

### Discussion of RQ1: Curricular Coverage Across Nigerian Universities

Our data analysis confirms that Nigerian universities implement the foundational subjects very well, for instance, Python programming (68%) and data visualization (52%) are well covered. However, they are still far behind in the mastering of the advanced and emerging fields such as ethical AI (13%), explainable AI (16%), cloud computing (28%), and deep learning (28%). The same trend has been found in the research of AI curricula in the developing world. In such regions, AI curricula heavily focus on programming fundamentals, leaving higher-order skills (e.g., ethics, governance, model deployment) largely unnoticed. Nevertheless, unlike India and South Africa which have already integrated ethical AI and cloud infrastructures in their undergraduate programs, Nigeria's uptake is still very slow. If no measures are taken, this will result in an increasingly wider skills gap.

### Discussion of RQ2: Faculty Competency Gaps

Faculty competency gaps were a lot more significant than curricular gaps. Ethical AI (66% deficiency), explainable AI (60%), and cloud computing (52%) were the areas that experienced the highest shortages. These data points hold water with the earlier research that indicates faculty expertise as the most important factor that determines a university's capability to upgrade computing curricula. The patterns of deficiencies also challenge the notion that a rise in student enrollment in computing programs would lead to increased institutional capacity. Instead, as it is the case in studies from Ghana and Kenya, the rapid growth of demand has outpaced the investments in faculty development. Therefore, if no measures are taken to upskill faculty, universities will be producing graduates with theoretical knowledge of AI but lacking competence in its practical application.

### Discussion of RQ3: Alignment with Global Competency Frameworks

The research unveiled that there is only a slight correspondence between the Nigerian curriculum and global standards such as CBE, EDSF, and the Responsible AI Framework by UNESCO. The main areas of focus in these frameworks such as ethical and reliable AI, data workflows based on cloud, and problem-solving across disciplines were only minimally represented in the existing curricula. The gaps identified are in line with the literature that points out that most African institutions are still concentrated on traditional computing while global frameworks advocate for the ethically, industry-linked and deployment-oriented competencies. However, a number of Nigerian institutions have shown partial alignment in programming and statistical fundamentals which could be seen as a stepping stone towards consolidation if strategic reforms are put in place.

### Discussion of RQ4: Institutional Barriers

Among the institutional obstacles that were highlighted are the lack of proper infrastructure, absence of industry partnerships, and the shortage of faculty skills. These obstructions are in

line with the national evaluations that point out the deteriorating state of laboratory infrastructure due to lack of investment, the limited availability of cloud computing environments, and poor collaboration between universities and tech companies. 相 compar to the expending AI education ecosystems in countries such as Egypt and Rwanda, the industry–academia linkage in Nigeria is still in its infancy. Towards real-world datasets and technologies, the weak partnership structure not only hampers access but also limits students' exposure to practical AI workflows. The contradiction between national digital policies and institutional realities calls for the need for enhanced governance, funding, and implementation mechanisms.

### Discussion of RQ5: Roadmap for Developing Next-Generation Skills

The four-pillar roadmap with the proposed pillars curriculum modernization, faculty development, industry partnerships, and infrastructure investment directly targets the systemic deficits revealed by the study. Such a roadmap is aligned with global best practices and is in agreement with the guidelines of UNESCO and EDSF. Unlike the previous suggestions that mainly focus on curricular revisions, the roadmap highlights the holistic restructuring of the AI education ecosystem. The focus on ecosystem-wide reform as opposed to recent curriculum-only interventions studies indicates the study's distinct impact on policy and institutional strategy. The combined findings from RQ1 to RQ5 depict an interconnected ecosystem of challenges that, as a whole, limit Nigeria's readiness for AI and data science education. Faculty competency deficiencies (RQ2) reinforce curricular gaps (RQ1), while the misalignment with global competency frameworks (RQ3) further hampers the integration of ethical, cloud-native, and advanced machine learning competencies. These academic limitations are, however, exacerbated by institutional barriers such as inadequate infrastructure and weak industry collaboration (RQ4) that create a structural environment in which universities are struggling to deliver modern, practice-oriented AI training. The four-pillar roadmap proposed in this study (RQ5) comprehensively addresses these interrelated gaps and thus constitutes a coherent strategy of not only transforming Nigeria's AI education landscape but also enhancing the country's capacity to competitively participate in the global digital economy.

## V. CONCLUSION

This research stands as the most detailed and thorough evidence-based evaluation of the readiness of Nigerian universities in providing innovative AI and data science education. Combining a bibliometric review, large-scale institutional survey, and expert validation, the findings point out substantial gaps in curricular coverage, faculty expertise, incorporation of ethical AI, and institutional infrastructure. In essence, these gaps hinder the production of graduates capable of engaging effectively in the global digital economy of Nigeria.

On the one hand, curricular analysis revealed high coverage of the technical subjects that form the base but adoption of emerging competencies like ethical AI, explainable AI, and cloud-native data workflows was extremely limited. Faculty proficiency scenarios were even bleaker, especially in areas that are both increasingly important and uncommonly known for AI. Besides that, poor alignment with global frameworks - for instance, CBE, EDSF, and UNESCO's Responsible AI Competency Framework - indicates a necessity of a competency-driven reform that is structured. On the other hand, lack of sufficient infrastructure and industry collaborations impede experiential learning and accessing real-world projects.

To remedy these system-wide problems, the research outlines a quadripartite roadmap comprising curriculum modernization, faculty development, industry collaboration, and strategic infrastructure investment. The suggested roadmap, as opposed to the limited

curriculum-only recommendations present in the current literature, views the ecosystem as a whole and thus, universities, policymakers, and industry actors are considered human-capital development co-contributors.

The study's significant contributions

- (a). A comprehensively verified diagnostic of curricular and faculty competency gaps in 15 Nigerian universities.
- (b). The first integrated conceptual model linking global competency frameworks with national capacity-building needs.
- (c). An all-inclusive and practically implementable roadmap, designed specifically for the Nigerian higher-education sector.
- (d). Empirical evidence to support national policy direction on AI workforce development and university reform.

The research, in essence, reveals that whereas Nigeria has some basic strengths, it still needs a well-coordinated, well-funded, and competency-oriented reform to equip students with skills matching AI developments. Enacting the suggested roadmap may, therefore, considerably speed up the country's journey towards crafting a competitive and future-ready workforce.

### Future Research Directions

Following studies may use more advanced analytical methods and widen the scope of institutional coverage to corroborate the findings of this work. In the first place, longitudinal research designs following changes of faculty competences, student skills, and modernization of the curriculum over several academic cycles would reveal more the dynamics of institutional transformation. Secondly, researches should implement objective performance assessments, practical evaluations in a lab, or standardized tests of competences to complement self-reported data and provide more accurate technical proficiency levels. Moreover, comparative studies between several countries in West Africa or even in sub-Saharan Africa could identify patterns at a regional level, common problems, and scalable models for AI capacity development. On the methodological side, the authors of the next paper may use multivariate or structural equation modeling techniques to investigate how infrastructure, faculty preparation, institutional policies, and curriculum alignment interact to predict student competency outcomes. The use of faculty upskilling programs, pilot curriculum modules, or structured industry partnership models as experimental or quasi-experimental interventions, thus, will help researchers to assess the causal effect of targeted reforms on learning outcomes and the level of readiness of the institution for AI-driven education.

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**APPENDIX A:** Slides Of the Paper Presented as the 1<sup>st</sup> International Conference of the Nigerian Society of Data Analyst and Business Intelligence Experts (NSDABIE) with the theme: AI and the Future of Data Professionals: Adapting, Thriving and Leading



**Developing Next-Generation Skills for Data Professionals in the Era of AI: A Roadmap for Nigerian Universities**

BY

● **Austin Olom Ogar**

CONFERENCE PRESENTATION

**Presentation Outline**

- 1 Abstract
- 2 Background of the Study
- 3 Statement of the Problem
- 4 Aim and Objectives.
- 5 Literature Review
- 6 Methodology
- 7 Result & Discussion
- 8 Conclusion
- References



## Abstract

- Purpose: Examine AI/data science skill gaps and propose a validated roadmap.
- Approach:
  - Mixed-methods
  - 1,050 respondents
  - 48 Scopus papers
  - Expert panel (CVI=0.82)
- Key Findings:
  - Ethical AI: 13% coverage
  - 66% faculty gap
  - Infrastructure deficits
- Contribution: Four-pillar reform strategy.



## Background of the Study

### Global AI Revolution

- AI, data science, automation transforming all sectors
- Finance, health, agriculture, education, public administration demand AI professionals
- Countries with robust education systems redesigning curricula and investing in workforce

### Research Gap

Prior research has often been fragmented, focusing on isolated aspects of AI education, narrow skill sets, or individual institutions, failing to provide a holistic view.

### Nigeria's Challenge

- Despite national initiatives (NDEPS, 3MTT, AI Academy):
- Outdated curricula
  - Faculty shortages
  - Limited infrastructure
  - Weak industry linkages

### This Study: A System-Wide Perspective

Our research offers a comprehensive evaluation, integrating multiple data sources – bibliometric analysis, extensive surveys, and expert insights – to provide a system-wide perspective.



## Statement of the Problem

### Challenge

Nigerian universities are currently struggling to produce data science graduates adequately prepared for the demands of an AI-driven global economy.

### Impact

Graduates lack practical competencies; Global skills gap persists; Nigeria cannot fully participate in the data-driven economy.

### Limitations of Current Approaches

- ❖ Curriculum Gaps:
  - Ethical AI 13%
  - XAI 16%
  - Cloud 28%
  - Deep Learning 28%
- ❖ Faculty Gaps:
  - 66% lack Ethical AI competence
  - 60% lack XAI competence
  - 84% unprepared for Responsible AI
- ❖ Structural Issues:
  - 87% lack HPC
  - 56% unreliable internet

## Related Works

Author / Study	Method / Focus	Key Findings	Limitations Noted
World Economic Forum (2023)	Global AI skills demand	AI skills top 5 most-demanded; 50% workforce needs reskilling	Establishes global urgency
UNESCO (2022)	Responsible AI frameworks	Ethics must be foundational, not optional	Validates ethical AI priority
EDISON (2022)	Data science competencies	Cloud, governance, lifecycle management essential	Informs curriculum design
Johnson & Lee (2023)	Faculty development gaps	Most faculty lack AI pedagogy training	Justifies faculty development pillar
Ashford et al. (2023)	Industry partnerships	Formal boards + resources critical for success	Validates industry collaboration model



## Aim and Objectives

### Primary Aim

To develop and validate a strategic, data-driven roadmap for strengthening AI and data science education in Nigerian universities, aligned with global competency frameworks and contextually suited to Nigeria's institutional landscape.

## Five Core Research Questions

### Curriculum Assessment

To what extent is key AI and data science curricular content introduced in Nigerian Universities?

### Faculty Readiness

Which competencies of faculty members teaching AI and data science courses are lacking?

### Framework Alignment

To what extent do university curricula correspond to global frameworks (CBE, EDSF, UNESCO Responsible AI)?

### Institutional Barriers

What institutional impediments prevent effective AI/data science education?

### Strategic Roadmap

What data-driven roadmap would help Nigerian universities educate the next-generation workforce?

Specific Objectives

Objective 1: Diagnose

- Assess curriculum content (IT domains)
- Evaluate faculty expertise gaps
- Measure alignment with international standards.

Objective 2: Validate

- Engage expert panel for roadmap validation
- Ensure contextual appropriateness
- Achieve expert consensus

Objective 3: Propose

- Develop evidence-based four-pillar strategy
- Specify implementation pathways
- Provide actionable recommendations

Objective 4: Disseminate

- Share findings with institutional leaders
- Inform national policy
- Enable system-wide reform



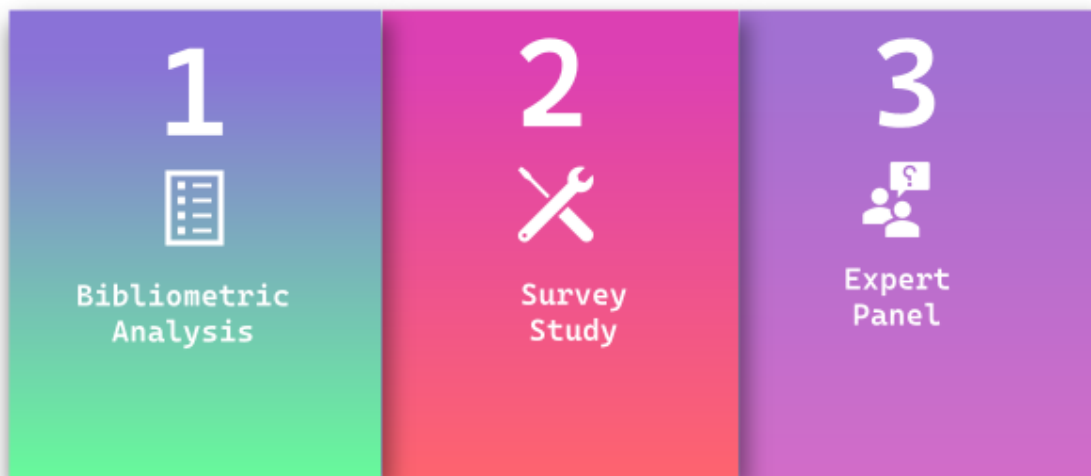
Methodology

Research Design: Convergent Mixed-Methods Approach



Quantitative and qualitative data were collected simultaneously, with integration during analysis and interpretation, providing strong triangulation and validation of findings.

## Data Source



## Survey Study



## Expert Panel



## Statistical Analysis

- **Descriptive:** Frequencies, percentages, means, SDs
- **Gap Scores:** Competence minus Industry Standard.
- **Inferential:** One-way ANOVA ( $\alpha=0.05$ ).
- **Post-hoc:** Bonferroni-corrected comparisons.
- **Qualitative:** Thematic analysis using ATLAS.ti.

## RESULTS

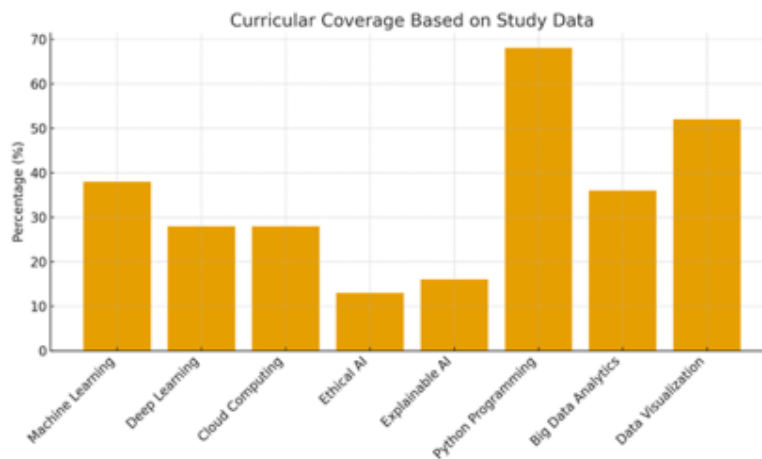


Figure 1. Curricular coverage of key AI and data science competencies across surveyed Nigerian universities.

## RESULTS

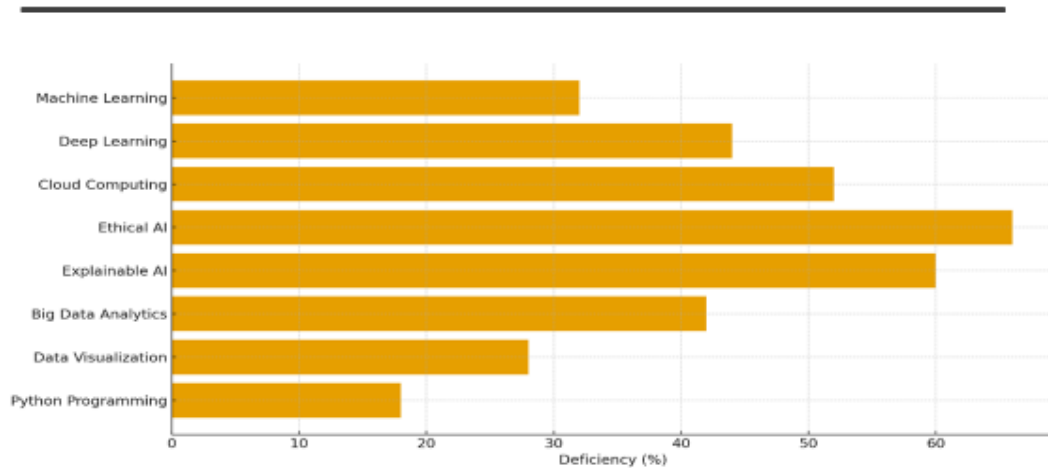


Figure 2. Faculty competency deficiency gaps across major AI and data science domains relative to industry standards

## FINDINGS

- ✓ Faculty Gaps:
  - Ethical AI: 2.1/5
  - Cloud: 2.4/5
  - Deep learning: 2.8/5
- ✓ Student Gaps:
  - Ethical AI: 1.3
  - XAI: 1.4
  - Deep Learning: 1.9
- Infrastructure:
  - 87% lack computing labs
  - 56% unreliable internet
- Industry:
  - 95% willing to support
  - Only 18% have formal partnerships
- ✓ Cause: Low curriculum coverage

## RECOMMENDATION

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- ✓ Four-Pillar Roadmap:
  - Curriculum Modernization
  - Faculty Development
  - Industry Collaboration
  - Infrastructure Investment

## RECOMMENDATION CONT

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- ✓ Implementation Timeline:
  - Q1: Curriculum audit, faculty assessment
  - Q2: Pilot rollout, computing labs
  - Q3: Scale curriculum, launch internships
  - Q4: Evaluate impact, full deployment

## RECOMMENDATION CONT

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- ✓ KPIs:
  - Curriculum:
    - 100% Ethical AI
    - 100% Cloud
  - Faculty:
    - 100% trained
    - 85% skills improvement
  - Industry:
    - 100% advisory boards
    - 95% internships
  - Infrastructure:
    - GPU labs in all institutions

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**THANK YOU  
ANY QUESTIONS?**