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Blueprint ICT Development (Blueprint-ICT-Dev)

STEM TRANSFORMATION STRATEGY DOCUMENT FOR HIGHER EDUCATION IN NIGERIA

(2026 – 2036)

A National Policy Framework for Science, Technology, Engineering and Mathematics Transformation

POLICY SUBMISSION TO THE NATIONAL UNIVERSITIES COMMISSION

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PREFACE

This document was prepared by the sub-committee on the Elaboration of the STEM Transformation Strategy for Higher Education inaugurated by The Executive Secretary, National Universities Commission (NUC), Professor Abdullahi Yusufu Ribadu, FCVSN on the 25th February, 2026.

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The Blueprint ICT Development project is an Agence Française de Développement (AFD)-funded intervention aimed at strengthening ICT infrastructure and human resources within the Nigerian University Education System (NUS).

FOREWORD

Nigeria stands at a defining moment in its development journey. As the global economy is increasingly driven by knowledge, digital technologies, artificial intelligence, innovation, and advanced manufacturing, the competitiveness of nations will depend largely on the strength of their higher education systems and their capacity to produce highly skilled graduates, cutting-edge research, and transformative innovations. Science, Technology, Engineering, and Mathematics (STEM), powered by Information and Communication Technology (ICT), therefore constitute the foundation upon which Nigeria's aspirations for economic diversification, industrialization, sustainable development, and global competitiveness must be built.

Nigeria's **ICT–STEM Transformation Strategy for Higher Education** presents a bold national roadmap for repositioning our universities, polytechnics, colleges of education, and research institutions to meet the demands of the Fourth and Fifth Industrial Revolution and the emerging digital economy. It provides a comprehensive framework for modernizing STEM education through world-class digital infrastructure, innovative curricula, industry-relevant skills development, research excellence, entrepreneurship, inclusive talent development, and strengthened partnerships among government, academia, industry, development partners, and the Nigerian diaspora.

This Strategy recognizes that transforming higher education requires more than investment in physical infrastructure. It demands a holistic approach encompassing effective governance, institutional autonomy, sustainable financing, faculty development, digital transformation, innovation ecosystems, quality assurance, research commercialization, and evidence-based policymaking. It also emphasizes equitable access, ensuring that women, persons with disabilities, and underserved regions fully participate in Nigeria's scientific and technological advancement.

The implementation of this Strategy shall strengthen the capacity of higher education institutions to produce graduates equipped with future-ready competencies, accelerate high-impact research and innovation, deepen collaboration with industry, and contribute significantly to national productivity, job creation, and socioeconomic development. By aligning higher education with national priorities and global best practices, Nigeria will be better positioned to become a regional leader in science, technology, innovation, and digital transformation.

This Strategy is the product of extensive consultation with government institutions, regulatory agencies, higher education institutions, research organizations, professional bodies, industry leaders, development partners, civil society organizations, and other critical stakeholders. Their valuable contributions have ensured that the Strategy reflects national priorities while embracing international standards and emerging global trends. Successful implementation will require sustained political commitment, coordinated institutional action, adequate and predictable financing, robust monitoring and evaluation, and continuous stakeholder engagement. Every stakeholder has an important role to play in translating this vision into measurable outcomes that will shape the future of Nigeria's higher education system.

As we embark on this transformative journey, I call upon all stakeholders to embrace this Strategy with dedication, innovation, and a shared sense of purpose. Together, we can build a resilient, inclusive, digitally enabled, and globally competitive higher education system that empowers our young people, drives scientific discovery, stimulates industrial innovation, and secures Nigeria's place among the world's leading knowledge economies.

Together, let us transform Nigeria's higher education system into a globally competitive engine of innovation, prosperity, and sustainable national development.

Professor Abdullahi Yusufu Ribadu
Executive Secretary
National University Commission

EXECUTIVE SUMMARY

Nigeria's aspiration to become a diversified, knowledge-driven, and globally competitive economy depends fundamentally on the transformation of its higher education system. In an era shaped by digital technologies, artificial intelligence, automation, data science, renewable energy, biotechnology, and advanced manufacturing, the country must urgently reposition its universities, polytechnics, colleges of education, and research institutions to produce the skilled workforce, research outputs, and technological innovations required for national development. This ICT-enabled STEM Transformation Strategy for Tertiary Education provides a comprehensive framework for achieving this objective.

The strategy responds to persistent structural challenges within Nigeria's tertiary education system, including inadequate digital infrastructure, obsolete laboratories and equipment, weak industry-academia linkages, limited research commercialization, outdated curricula, poor pedagogical training, insufficient postgraduate and doctoral capacity, inadequate funding, fragmented governance systems, low digital literacy levels, and waste of talent due to persistent disparities in access to STEM education, particularly among women and underserved regions. These challenges continue to limit the ability of Nigerian institutions to compete globally and contribute effectively to national innovation and industrial growth.

The strategy therefore proposes a coordinated national transformation agenda that integrates Information and Communication Technology (ICT) with Science, Technology, Engineering, and Mathematics (STEM) education to build a modern, inclusive, research-driven, innovation-oriented, and industry-responsive tertiary education ecosystem.

The overarching goal of the strategy is to develop a globally competitive ICT-enabled STEM tertiary education system that supports economic diversification, industrialisation, digital transformation, entrepreneurship, sustainable development, and national competitiveness. The strategy seeks to strengthen human capital development, inclusivity, expand research and innovation capacity, improve graduate employability, stimulate technology transfer and commercialisation, and position Nigeria as a regional hub for scientific and technological advancement.

To achieve these objectives, the strategy is structured around several strategic pillars. First, it prioritises the modernisation of ICT and research infrastructure through broadband expansion, smart classrooms, virtual laboratories, high-performance computing facilities, digital libraries, research equipment modernisation, national research and education networks, and institutional digital transformation platforms. These investments will create enabling environments for teaching, learning, research, collaboration, and innovation.

Second, the strategy emphasises curriculum reform and digital skills development to align tertiary education programmes with emerging global technologies and labour market demands. This includes integrating artificial intelligence, robotics, cybersecurity, cloud computing, Internet of Things (IoT), data analytics, coding, renewable energy technologies, and entrepreneurship into STEM curricula. The strategy also promotes competency-based learning, interdisciplinary education, experiential learning, and flexible digital learning models.

Third, the strategy seeks to strengthen research, innovation, and commercialisation ecosystems by establishing Centres of Excellence, innovation hubs, research clusters, technology incubation centres, and industry-supported research programmes. It promotes stronger collaboration among academia, industry, government, and international partners to improve knowledge transfer, patent generation, technology commercialization, and start-up development.

Fourth, the strategy seeks to improve the quality of STEM aspirants and undergraduates through several academic support strategies. It also recognizes the importance of postgraduate education and advanced research training. It therefore proposes expansion of doctoral and postdoctoral programmes, joint and cotutelle PhD arrangements, international research collaborations, faculty development initiatives, and diaspora engagement programmes to strengthen Nigeria's scientific and research capacity.

Fifth, the strategy prioritizes governance and institutional reforms to improve policy coordination, accountability, quality assurance, financing mechanisms, and implementation effectiveness. It recommends the establishment of inter-ministerial coordination frameworks, strengthened regulatory systems, performance-based funding models, public-private partnerships, and robust monitoring and evaluation systems supported by measurable Key Performance Indicators (KPIs) and Disbursement Linked Indicators (DLIs).

The strategy also places strong emphasis on inclusion, gender equity, regional balance, and accessibility to ensure that women, persons with disabilities, and underserved communities benefit equitably from STEM opportunities. It promotes targeted scholarships, mentorship programmes, digital inclusion initiatives, and regional capacity-building interventions to address longstanding inequalities.

Implementation of the strategy will occur in phased stages over short, medium, and long terms, with clearly defined communication methods, institutional responsibilities, financing arrangements, risk mitigation measures, and performance monitoring mechanisms. Federal and state governments, tertiary institutions, regulatory agencies, industry stakeholders, professional associations, development partners, and the Nigerian diaspora are all expected to play critical roles in implementation.

The estimated investment required over a 10-year period reflects the scale of transformation needed to reposition Nigeria's tertiary education system for competitiveness in the global digital and knowledge economy. These investments should not be viewed solely as educational expenditure, but as strategic national investments in economic diversification, industrialization, technological sovereignty, digital transformation, youth empowerment, research excellence, and sustainable development. If effectively financed and implemented, the strategy has the potential to transform Nigeria into a leading African hub for science, technology, innovation, entrepreneurship, and advanced digital capabilities.

The successful implementation of this ICT-enabled STEM Transformation Strategy is expected to deliver significant national benefits, including enhanced graduate employability, increased research productivity, improved innovation capacity, stronger industry linkages, growth in technology-based enterprises, increased global competitiveness of Nigerian institutions, improved digital literacy, and accelerated socioeconomic development. The strategy will also support Nigeria's broader national priorities, including economic diversification, youth

empowerment, industrialization, digital economy expansion, environmental sustainability, and achievement of the Sustainable Development Goals (SDGs).

Ultimately, this strategy represents more than an education reform programme; it is a national development blueprint for building the human capital, scientific capabilities, technological ecosystems, and innovation capacity necessary for Nigeria to thrive in the twenty-first century global knowledge economy.

Nigeria's higher education system must be transformed to make STEM (Science, Technology, Engineering, and Mathematics) the foundation of national development. This strategy provides a 10-year roadmap (2026–2036) to modernize curricula, strengthen faculty capacity, expand infrastructure, and deepen industry-academia linkages.

By 2036, Nigerian universities shall serve as hubs of innovation and entrepreneurship, producing graduates who are globally competitive and capable of addressing national challenges in energy, food security, health, climate resilience, and digital transformation.

Prof. Oluwatoyin T. Ogundipe FAS

Chair, Blueprint ICT-Dev STEM Committee

KEY POLICY RECOMMENDATIONS

1. Governance and Leadership

1. Establish a **STEM Transformation Directorate** within NUC to coordinate national implementation.

2. Facilitate an Inter-Ministerial Coordination Mechanism (IMCM)
3. Introduce **performance-based funding** tied to STEM research output, patents, and graduate employability.
4. Ensure Policy Continuity and Long-Term Political Commitment
5. Ensure Legislative backing for key reforms
6. Facilitate a national stakeholder ownership framework

2. Funding and Resource Mobilization

1. Allocate **20% of tertiary education funding** to STEM programs and infrastructure.
2. Create a **National STEM Innovation Fund** to support university-led startups and commercialization.
3. Incentivize private sector co-investment in labs, scholarships, and innovation hubs.
4. Facilitate international donor and development financing
5. Establish education bonds, venture capital and innovation financing schemes

3. Curriculum and Pedagogy Reform

1. Integrate **emerging technologies** (AI, robotics and automation, machine learning, Internet of things, cloud computing, data analytics, cybersecurity) into STEM curricula.

2. Crate curriculum in stem fields for the future that aligns with national development priorities.
3. Mandate **industry internships and applied projects** as graduation requirements.
4. Adopt **digital learning platforms** and e-labs to modernize teaching delivery.
5. Establish **periodic curriculum review mechanisms** to maintain relevance and global competitiveness
6. Institutionalize **digital learning and hybrid education systems in tertiary institutions**
7. Institutionalize **digital assessment and certification system**

4. Faculty Development and Research Capacity

1. Implement **continuous training** in emerging technologies and pedagogy for staff.

2. Implement **continuous training of staff and students** on research, innovation and entrepreneurship

3. Implement **continuous training** for technologists and technicians in equipment management and maintenance
4. Facilitate **international exchange programs** for faculty and researchers.
5. Provide **research grants and incentives** for high-impact publications and patents.
6. Strengthen **research, innovation and commercialization ecosystems**.

7. Support creation of regional specialized centres of excellence, research clusters and innovation hubs
8. Create **funding for doctorial and postdoctoral training** in specialized STEM fields
   Encourage tertiary institutions to **develop joint and cotutelle PhD** programmes
9. Encourage **diaspora teaching and research engagements** initiatives
10. Create **competitive research fellowships**
    Facilitate **Industry immersion and sabbatical programmes**

5. Infrastructure Modernization

1. Establish at least **12 world-class STEM innovation hubs** across Nigerian universities.
2. Ensure **high-speed internet connectivity** in all institutions by 2030.
3. Designate **regional centers of excellence, research clusters and innovation hubs** specializing in priority STEM fields.
4. Create Smart classrooms, virtual laboratories and simulation
5. Develop virtual learning systems, learning management system (LMS)
6. Expansion of **NgRen and TERAS across** Nigerian Tertiary Institutions
7. Modernise STEM laboratories, workshops equipment and maintenance
8. Encourage tertiary education to develop open educational resources (OER)

6. Equity and Inclusion

1. Target **80% female enrollment** in STEM programs by 2036.
2. Expand scholarships for females, disadvantaged and underrepresented groups.
3. Ensure accessibility for students with disabilities in labs and digital platforms.
4. Promote Inclusion, Gender Equity, and regional balance in STEM Education
5. Expand rural connectivity and remote learning support
6. Institutionalize mentorship programmes for girls in STEM in tertiary institutions
7. Encourage advancement of Women in STEM academics

7. Industry-Academia Linkages

1. Formalize **national STEM internship and apprentice schemes** with leading industries.
2. Establish **technology transfer offices** in universities to patent and market innovations.
3. Align STEM research with **national development priorities** (energy, food security, ICT, health).
4. Mandate industry participation in curriculum development
5. Provide financial incentives for private sector investment in tertiary education research collaboration, technology park and graduate apprenticeships
6. Mandate industries to fund industry chairs and endowment in priority areas

8. Monitoring and Evaluation

1. Develop Robust Monitoring, Evaluation, and Data Systems
2. Track progress through **annual performance audits** and public reporting.
3. Engage **independent evaluators** every 5 years to assess impact.
4. Adapt policies to reflect emerging global trends and national needs.
5. Monitoring systems to incorporate Key Performance Indicators (KPIs), Disbursement Linked Indicators (DLIs), and periodic independent evaluations.
6. Accreditation to include performance on STEM integration and transformation

Investment Requirements

Transforming STEM education requires sustained investment across five priority areas:

1. ICT and digital Infrastructure Development
    - Establish 12 world-class STEM innovation hubs.
    - Smart classrooms and digital learning management platforms (LMS).
    - Expand broadband connectivity and back up renewable energy adoption.
    - Digital libraries and e-resources.
    - Virtual laboratories and simulation systems
2. Faculty and Human Capital Development
    - Continuous training in emerging technologies.
    - International exchange programs and joint research initiatives.
    - Faculty digital skills training
    - Faculty research capacity building
    - Technical staff training
    - Doctoral and postdoctoral scholarships
    - Industry immersion programmes
    - Diaspora academic engagement
3. Curriculum Reform & Digital Integration
    - Integrate AI, robotics, Internet of things, data analytics, cloud computing, and cybersecurity into STEM.
    - Adopt e-learning platforms and simulation labs.
    - Support interdisciplinary programs linking STEM with entrepreneurship.
    - STEM curriculum modernization
    - Emerging STEM programme development
    - Open education resources
    - Digital accreditation and assessment system
    - Virtual STEM learning content
4. Research infrastructure, Innovation and commercialization
    - Research, innovation and technology grants.
    - Establishment of centres of excellence, innovation hubs and research clusters
    - Modernization of laboratories, equipment and maintenance
    - Research Management systems
    - National Equipment portal system
    - Patent, intellectual property and commercialization grants
    - Startups and commercialization funds
5. Equity & Inclusion Programs
    - Scholarships for women, disadvantaged groups, and students with disabilities.
    - Outreach programs to secondary schools.
    - Accessibility upgrades for laboratories, workshops and digital platforms.
    - Preparation of incoming students (foundation programmes)
    - Students' innovation grants
    - Rural digital inclusion programmes
    - Assistive Technology for disabilities

6. Industry-Academia Partnerships and Technology Transfer

    - Establish technology transfer offices in tertiary institutions.
    - Industry-academia research and technology development partnership
    - Launch national STEM internship and apprentices' schemes.
    - Co-invest in applied research and commercialization projects.
    - Industry innovation funds
    - Technology parks and innovation corridors
7. Governance, Monitoring and Evaluation
    - Expansion of NgRen and TERAS
    - Financial and Procurement Digitization
    - Enterprise Resource Planning systems
    - Data Analytics and Institutional Dashboards
    - Performance tracking systems
    - Independent evaluation systems
    - Legal and regulation modernisation
    - National and State co-ordination secretariat

Multi-Source Financial Model

A multi-source funding model is proposed to include:

1. **Government Allocations:**
   Federal and state education budgets.
2. **Private Sector:**
   Incentives for co-investment in labs, scholarships, and innovation hubs.
3. **International Development Partners:**
   Grants and technical assistance from UNESCO, World Bank, AfDB, and bilateral donors.
4. **National STEM Innovation Fund:**
   Dedicated fund for university-led startups and commercialization.
5. **Institutional budgets and endowments**

Expected National Impact

1. Economic Growth and Diversification

- STEM-driven industries will reduce dependence on oil revenues.
- Commercialization of university research will generate new enterprises and jobs.
- By 2036, STEM graduates will contribute significantly to GDP growth through innovation and entrepreneurship.
- Expansion of Nigeria' s digital economy through expansion of digital literacy, ICT infrastructure, and advanced technology skills across tertiary institutions
- Growth in digital entrepreneurship (baseline and future targets)

2. Human Capital Development

- STEM enrollment will rise by 50%, with gender parity achieved by 2036.

- Nigerian universities will produce globally competitive graduates equipped with 21st-century skills.
- Faculty development programs will elevate teaching and research standards to international benchmarks.
- Nigerian institutions are expected to improve their rankings, reputation, and global competitiveness.
- Increase in global knowledge exchange, international visibility, and access to international funding and research opportunities

3. Technological Innovation and Global Competitiveness

- Establishment of at least 12 world-class STEM innovation hubs will position Nigeria as a leader in African research output.
- Increased patents, publications, and startups will enhance Nigeria's global reputation in science and technology.
- Integration of AI, robotics, data analytics, internet of things, cloud computing, into curricula will align Nigeria with global innovation trends.

4. Social Inclusion and Equity

- Expanded scholarships and outreach programs will ensure access for women, disadvantaged groups, and students with disabilities.
- STEM education will become a tool for social mobility, reducing inequality and empowering marginalized communities.

5. National Security and Sustainability

- STEM innovation to strengthen Nigeria's capacity to address food security, climate change, public health, and cybersecurity.
- Adoption of renewable energy and sustainable practices in universities will model national resilience.
- Research aligned with national priorities (food security, energy security, economic growth, job creation and diversification) to enhance Nigeria's ability to respond to emerging challenges.

Table 1-4 provides clear, measurable indicators that policymakers can track annually to evaluate progress and ensure accountability. This dashboard provides a robust results framework that can support annual performance reviews, mid-term evaluations (2030), and the final impact assessment (2036).

Table 1: Impact Metrics Dashboard (2026–2036)

Strategic Impact Area	Impact Metric	2026 Baseline	2027 Target	2030 Target	2035 Target	Means of Verification
Digital Infrastructure	HEIs with high-speed broadband (%)	35%	65%	90%	100%	NUC/NBTE/NCCE ICT Audit
	Smart classrooms established	300	2,500	7,000	12,000	Institutional Reports
	Virtual laboratories operational	20	200	600	1,200	Laboratory Database
	Institutions connected to National Research & Education Network	60	180	320	All HEIs	NgREN Reports
Digital Learning	Courses delivered through LMS (%)	20%	50%	80%	100%	LMS Analytics
	AI-enabled learning systems deployed	Pilot	50 institutions	200 institutions	All HEIs	Institutional ICT Reports
	Students with digital identity	15%	70%	100%	100%	National Student Database
STEM Enrolment	Annual STEM enrolment	850,000	1.1 million	1.5 million	2 million	NUC/NBTE Statistics
	Female STEM participation (enrollment)	32%	38%	45%	50%	Gender Statistics
	Students from underserved regions	Baseline	+20%	+40%	+60%	Institutional Records

Table 2. Research, Innovation and Human Capital Dashboard

Strategic Area	Impact Metric	2026	2027	2030	2035	Data Source
Research Capacity	Annual Scopus-indexed publications	18,000	25,000	40,000	65,000	Scopus/Institutional Reports
	Research grants secured annually	₦120 Billion	₦250 Billion	₦500 Billion	₦1 Trillion	TETFund/Funding Agencies
	International collaborative publications	28%	40%	55%	70%	Bibliometric Database
	Patents filed annually	220	600	1,500	3,000	Patent Registry
Innovation	University spin-off companies	40	120	350	800	Technology Transfer Offices
	Start-ups incubated annually	200	800	2,500	6,000	Innovation Hubs
	Research commercialisation rate	5%	12%	25%	40%	Commercialisation Office
Human Capital	PhD graduates annually	8,000	12,000	20,000	35,000	NUC
	HE staff completing digital CPD annually	5,000	30,000	70,000	120,000	CPD Portal
	HE Staff with CPD certification	Baseline	10%	30%	60%	CPD Portal
	International research fellowships	300	800	2,000	5,000	Institutional Reports

Table 3. Industry, Employment and Economic Impact Dashboard

Strategic Area	Impact Indicator	2026	2027	2030	2035	Verification
Graduate Employability	STEM graduate employment within 12 months	20%	65%	75%	90%	Graduate Tracer Survey
	Students completing internships	35%	70%	90%	100%	SIWES Reports
Industry Collaboration	Active industry partnerships	300	900	2,000	5,000	Partnership Database
	Industry-funded research (%)	8%	15%	25%	40%	Institutional Finance Reports
Entrepreneurship	Student start-ups created annually (funded)	90	2,000	5,000	10,000	Innovation Centres
Economic Contribution	ICT-STEM contribution to GDP	Baseline	+2%	+5%	+10%	National Bureau of Statistics
	Knowledge economy jobs created	Baseline	250,000	1 million	3 million	Labour Statistics

Table 4. Governance, Sustainability and Global Competitiveness Dashboard

Strategic Area	Indicator	2025	2027	2030	2035	Verification
Governance	Institutions with digital governance systems	20%	60%	90%	100%	Digital Governance Audit
	Annual institutional performance scorecards published	10%	60%	100%	100%	Ministry Reports
Quality Assurance	Accredited ICT-STEM programmes	65%	80%	95%	100%	Accreditation Reports
Internationalisation	Foreign students enrolled	25,000	40,000	70,000	120,000	International Offices
	International faculty (%)	2%	5%	10%	15%	HR Records
Sustainability	Institutions using renewable energy (%)	10%	35%	70%	100%	Energy Audit
	Green campuses certified	5	40	120	250	Sustainability Reports
Global Competitiveness	Nigerian universities in global Top 1000	2	20	40	60	International Rankings
	Universities in Africa Top 100	13	30	45	60	Ranking Agencies

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LIST OF ACRONYMS AND ABBREVIATIONS

ACE	Africa Centre of Excellence
AI	Artificial intelligence
BMAS	Benchmark Minimum Academic Standards
CCMAS	Core Curriculum and Minimum Academic Standards
CPD	Continuous Professional Development
EMIS	Education Management Information System
ETF	Education Trust Fund
FME	Federal Ministry of Education
FMIST	Federal Ministry of Innovation, Science and Technology
GDP	Gross Domestic Product
GIS	Geographic Information System
HEMIS	Higher Education Management Information System
HND	Higher National Diploma
HPC	High-performance computing
ICT	Information and Communication Technology
IGR	Internally generated revenue
IMCM	Inter-Ministerial Coordination Mechanism
KPI	Key performance indicator
LMS	Learning management platforms
MEL	Monitoring, Evaluation and Learning
MER	Monitoring and Reporting
NBS	National Bureau of Statistics
NBTE	National Board for Technical Education
NCC	Nigerian Communications Commission
NCCE	National Commission for Colleges of Education
NCE	Nigeria Certificate in Education
ND	National Diploma
NDEPS	Digital Economy Policy and Strategy

NDP	National Development Plan
NESRI	Nigeria Education Sector Renewal Initiative
NITDA	National Information Technology Development Agency
NOTAP	National Office for Technology Acquisition and Promotion
NPE	National Policy on Education
NPSTE	National Policy on Science and Technology Education
NRF	National Research Fund (TETFund)
NSRF	National STEM Results Framework
NSTIP	National Science, Technology and Innovation Policy
NUC	National Universities Commission
OBE	Outcome-based education
OECD	Organisation for Economic Co-operation and Development
OER	Open educational resources
PBL	Problem-based learning
PMO	Programme Management Office
PMU	Programme Management Unit
RIMS	Research Information Management Systems
SDG	Sustainable Development Goal
SIWES	Student's Industrial Work Experience
SME	Small and Medium-sized Enterprise
STEM	Science, Technology, Engineering, and Mathematics
STI	Technology and Innovation
TERAS	Tertiary Education Research Application and Services
TETFUND	Tertiary Education Trust Fund
TVET	Technical and Vocational Education and Training
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION AND NATIONAL CONTEXT

1.1 Background and Rationale

Nigeria's higher education system stands at a critical juncture. The nation's demographic trajectory, with a population projected to exceed 250 million by 2036, presents both a challenge and an opportunity. Harnessing this youthful population requires deliberate investment in education, particularly in Science, Technology, Engineering, and Mathematics (STEM), which are globally recognised as the drivers of innovation, industrialisation, and sustainable development.

At present, Nigerian universities and tertiary institutions face systemic constraints: inadequate infrastructure, outdated curricula, limited industry linkages, and a shortage of qualified STEM educators. These challenges hinder the ability of higher education to produce graduates who are globally competitive and locally relevant. Without decisive action, Nigeria risks falling behind in the global knowledge economy.

The STEM Transformation Strategy (2026–2036) has therefore been developed to reposition higher education as a cornerstone of national development. It is anchored on the recognition that STEM education is essential for:

i. **Economic diversification and industrialization**
   Nigeria's long-standing dependence on oil revenues has exposed the economy to external shocks, fiscal instability, and limited industrial competitiveness. Sustainable economic diversification requires strong investment in science, technology, innovation, and human capital development into technology-driven sectors such as renewable energy, biotechnology, and digital services.

ii. **Job creation and youth empowerment**
   Nigeria possesses one of the world's largest youth populations, with a rapidly expanding demand for quality tertiary education and employment opportunities. This demographic advantage can become either a major national asset or a socioeconomic liability depending on the country's ability to equip young people with relevant STEM and digital competencies. Addressing high unemployment rates by equipping graduates with skills for emerging industries.

iii. **The Fourth Industrial Revolution and Global Technological Disruption**
   This offer's Nigeria an opportunity to accelerate the pace towards building an effective national innovation system. The global economy is increasingly driven be technologies including Artificial intelligence, robotics and automation, big data analytics, cloud computing, internet of Things, blockchain, additive manufacturing among others. Countries that fail to prepare their workforce and institutions for these technological shifts risk marginalization in the global economy

iv. **Growing Digital Economy and Labour Market Needs**
   Nigeria's digital economy is expanding rapidly, creating demand for advanced digital and STEM competencies. The growth of sectors such as ICT services, E-commerce, Financial technology, Digital media, Cybersecurity, Software engineering etc requires a workforce with modern technical and digital capabilities. However, many graduates

currently lack Industry-relevant ICT skills, practical problem-solving abilities, entrepreneurial competencies, digital literacy and applied technical expertise. Transforming higher education STEM education is strategically important for closing digital skills gaps.

v. **Persistent Graduate Unemployment and Skills Mismatch**

A pressing national challenge is the growing mismatch between graduate competencies and labour market requirements. Many employers report shortages in technical STEM skills, digital competencies, innovation capabilities, practical engineering skills, research and analytical capacity. This mismatch has contributed to high graduate unemployment, underemployment, reduced productivity, brain drain, and low industrial competitiveness. Strategic STEM transformation is therefore required to align curricula with labour market demands, promote competency-based education, strengthen experiential learning, improve industry-academia collaboration and foster entrepreneurship and innovation

vi. **National Security and Technological Sovereignty**

Technological capability increasingly influences national security, economic independence, and geopolitical relevance. Nigeria remains heavily dependent on imported technologies, software systems, industrial equipment, and technical expertise. This dependency weakens national technological sovereignty, cybersecurity resilience, industrial competitiveness, scientific self-reliance. Transforming STEM education is strategically critical for building indigenous technological capacity, supporting local innovation ecosystems, enhancing cybersecurity capabilities, developing strategic industries and reducing technological dependency

vii. **Regional and Global Competitiveness**

Nigeria risks losing regional and global competitiveness if higher education remain underfunded, technologically outdated, and disconnected from global innovation systems. Strategic STEM transformation will help Improve global university rankings, increase international collaboration, attract research funding and investment, enhance regional leadership in Africa, strengthen participation in global knowledge economies and ensuring Nigeria can participate meaningfully in international research, innovation, and trade.

viii. **Social inclusion and equitable development**

Significant disparities remain in access to STEM education across gender groups, geographic regions, rural and urban communities, marginalized groups, socioeconomic backgrounds. Women and underserved populations remain underrepresented in many STEM disciplines. Strategic transformation is necessary to expand equitable access to STEM opportunities, promote gender inclusion, support digital inclusion, reduce regional disparities, strengthen national cohesion and social mobility. Inclusive STEM education development is essential for balanced national growth.

ix. **Institutional Modernization and Governance Reform**

Many tertiary institutions face governance and operational challenges including Weak institutional autonomy, inefficient administrative systems, poor data management, limited accountability, fragmented policy coordination. ICT-enabled transformation offers opportunities to modernize institutional management systems, quality assurance processes, data-driven planning, digital governance systems and monitoring and evaluation frameworks. Improved governance is essential for sustainable transformation outcomes.

An ICT-enabled STEM transformation for higher education is therefore not optional; it is a national strategic necessity. It represents the foundation for building the human capital, innovation systems, technological capabilities, and institutional resilience required for Nigeria to compete effectively in the global knowledge economy. By transforming higher STEM education, Nigeria can unlock its vast demographic and intellectual potential, accelerate sustainable development, strengthen national competitiveness, and position itself as a leading African hub for science, technology, innovation, and digital transformation. This strategy therefore aligns with Nigeria's broader national development priorities, including the National Development Plan (2021–2025)[1] and the African Union's Agenda 2063.[2]

1.2 Nigeria's Demographic and Economic Imperatives

Nigeria's demographic and economic realities underscore the urgency of transforming higher education in STEM fields. With a population projected to exceed 250 million by 2036, Nigeria is poised to become one of the most populous nations in the world. This demographic trajectory presents both opportunities and challenges: a youthful population can serve as a powerful engine of innovation and productivity, but only if adequately equipped with the skills and knowledge demanded by the global economy.

The economic imperative is equally pressing. Nigeria's economy remains heavily dependent on oil revenues, leaving it vulnerable to global market fluctuations and environmental concerns. Diversification into technology-driven sectors such as renewable energy, biotechnology, digital services, and advanced manufacturing is essential for sustainable growth. STEM education is the foundation for this transition, providing the human capital required to drive industrialisation, digital transformation, and knowledge-based development.

At present, the mismatch between higher education outputs and labour market needs contributes to high youth unemployment and underemployment. Employers consistently report gaps in technical skills, problem-solving abilities, and innovation capacity among graduates. Addressing these gaps requires a deliberate restructuring of STEM education to align with national development priorities and global standards.

The demographic and economic imperatives, therefore, demand a strategic transformation of STEM higher education that:

1. Harnesses Nigeria's youthful population as a demographic dividend.
2. Equips graduates with globally competitive skills for emerging industries.
3. Reduces reliance on oil by fostering innovation-driven economic diversification.
4. Positions Nigeria as a regional leader in science, technology, and innovation.

1.3 Policy Mandate of the Federal Ministry of Education

The **Federal Ministry of Education (FME)** is the lead government institution responsible for the formulation, coordination, implementation, and monitoring of national education policies in Nigeria. It provides strategic leadership for the education sector and ensures that education

[1] Federal Government of Nigeria (FGN). (2021). National Development Plan (2021–2025).

[2] African Union. (2015). Agenda 2063: The Africa We Want. Addis Ababa: African Union Commission.

contributes to national development through quality, equitable, and inclusive learning opportunities. Its mandate is derived from the **1999 Constitution of the Federal Republic of Nigeria (as amended)**, the **National Policy on Education**[3], and other relevant education laws and regulations. The Ministry oversees education through its departments and agencies, including the National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, and Universal Basic Education Commission.

The Ministry's core mandate includes:

1. Formulation and Coordination of National Education Policy

The Ministry formulates, reviews, and coordinates national education policies to ensure that Nigeria's education system supports national development priorities, human capital development, and global competitiveness. It also coordinates policy implementation across all levels of government.

2. Educational Planning and Policy Development

The Ministry collects, analyzes, and disseminates education data for planning, budgeting, monitoring, and evaluation. It develops strategic plans, sector-wide policies, and reform initiatives to improve educational outcomes nationwide.

3. Setting and Maintaining National Standards

The Ministry prescribes and maintains minimum standards for education across Nigeria through collaboration with its regulatory agencies. It ensures consistency in educational quality while supporting continuous curriculum improvement and institutional development.

4. Quality Assurance and Inspection

Through its Quality Assurance Services and regulatory agencies, the Ministry monitors educational institutions, evaluates teaching and learning, and ensures compliance with national standards to improve educational quality and accountability.

5. Curriculum Development and Educational Innovation

The Ministry collaborates with relevant agencies, including the Nigerian Educational Research and Development Council, to develop, review, and modernize national curricula, promote digital learning, strengthen STEM education, and integrate entrepreneurship, technical education, and twenty-first-century skills into teaching and learning.

6. Coordination of Basic, Secondary, and Tertiary Education

The Ministry coordinates education across all levels by supervising federal educational institutions and providing policy direction to agencies responsible for universities, polytechnics, colleges of education, and basic education. It promotes coherence throughout the education system.

[3] Federal Republic of Nigeria. (2013). National Policy on Education (6th Edition). Abuja: Federal Ministry of Education.

7. Human Capital Development

The Ministry promotes equitable access to quality education, teacher development, skills acquisition, technical and vocational education, research, innovation, and lifelong learning to build a productive workforce capable of supporting national economic transformation.

8. International Cooperation

The Ministry represents Nigeria in international education initiatives and coordinates cooperation with development partners, multilateral organizations, and foreign governments on education policy, capacity building, scholarships, and technical assistance.

9. Promotion of Equity and Inclusive Education

The Ministry develops policies that expand access to education for girls, children with disabilities, disadvantaged populations, and underserved communities, while promoting inclusive, equitable, and lifelong learning opportunities.

10. Monitoring and Evaluation of Education Sector Performance

The Ministry monitors implementation of education policies and programmes, evaluates sector performance, and recommends reforms that improve governance, financing, efficiency, and learning outcomes across Nigeria's education system.

The STEM Transformation Strategy (2026–2036) is therefore fully aligned with the Federal Ministry of Education's mandate to strengthen the quality and relevance of higher education. It provides a structured roadmap for achieving the Ministry's vision of an education system that produces globally competitive graduates, fosters innovation, and contributes to Nigeria's sustainable economic growth.

1.4 Policy Mandate of National Universities Commission

The **National Universities Commission (NUC)** is the principal regulatory agency responsible for the planning, coordination, quality assurance, relevance, accountability and development of university education in Nigeria. Established in **1962** as an advisory body and transformed into a statutory agency by **Decree No. 1 of 1974** (now the **National Universities Commission Act, Cap N81, Laws of the Federation of Nigeria 2004**), the NUC serves as the Federal Government's primary institution for regulating the Nigerian University System. The NUC's mandate is central to the successful implementation of the STEM Transformation Strategy (2026–2036).

The policy mandate of the NUC include:

1. Regulation of University Education

The NUC regulates the establishment, governance, and operation of universities in Nigeria to ensure an orderly, coordinated, and sustainable university system that supports national development. Supporting universities in strengthening faculty expertise, research capacity, and institutional governance

2. Academic Standards and Quality Assurance

One of the Commission's principal mandates is to establish and periodically review **Benchmark Minimum Academic Standards (BMAS)** (now evolving toward the Core Curriculum and Minimum Academic Standards, CCMAS), ensuring that all academic programmes meet nationally approved quality standards. The NUC conducts programme accreditation, institutional accreditation, and quality assurance reviews across Nigerian universities.

3. Accreditation of Academic Programmes

The Commission approves and accredits undergraduate and postgraduate programmes offered by universities. Accreditation assesses curriculum quality, staffing, infrastructure, laboratories, libraries, governance, funding, and learning outcomes before and during programme implementation.

4. Approval of Universities

The NUC evaluates applications and recommends the establishment of federal, state, and private universities. It issues provisional licences to eligible private universities and monitors compliance with regulatory requirements before granting full operational status.

5. Policy Advice to Government

The Commission advises the Federal and State Governments on all matters relating to university education, including higher education policy, institutional development, financing, governance reforms, and strategic planning. Aligning university policies with national education strategies and broader development frameworks, including Nigeria’s National Development Plan and the African Union’s Agenda 2063

6. Strategic Planning and Coordination

NUC prepares national plans for the balanced development of university education, including projections for student enrolment, academic programmes, infrastructure, research capacity, and human resource development. It ensures that university expansion aligns with national manpower and economic needs.

7. University Funding and Resource Planning

The Commission advises government on the recurrent and capital funding requirements of universities, including research funding needs, and makes recommendations to improve the efficient allocation and utilization of resources within the university system. Guiding investments in laboratories, digital platforms, and innovation hubs to ensure equitable access and effective utilization.

8. Research, Innovation and International Competitiveness

The NUC promotes research excellence, innovation, digital transformation, entrepreneurship, and international collaboration. It supports curriculum modernization and encourages universities to produce graduates with competencies that meet national and global labour market demands.

9. Coordination of External Assistance

The Commission serves as the official channel through which international grants, development assistance, and technical support are coordinated for Nigerian universities, ensuring alignment with national higher education priorities.

10. Monitoring and Institutional Development

The NUC continuously monitors universities to ensure compliance with approved standards in governance, academic delivery, staffing, infrastructure, and financial management. It also promotes institutional self-assessment and continuous quality improvement.

The STEM Transformation Strategy (2026–2036) is fully aligned with the NUC's mandate to regulate, coordinate, and advance university education in Nigeria. By embedding STEM priorities into accreditation processes, policy frameworks, and institutional support mechanisms, the NUC will play a pivotal role in ensuring that Nigerian universities produce graduates who are globally competitive, nationally relevant, and capable of driving innovation-led growth.

1.5 Policy Mandate of the National Board for Technical Education

The National Board for Technical Education (NBTE) is the statutory regulatory agency responsible for the coordination, regulation, quality assurance, and development of **Technical and Vocational Education and Training (TVET)** in Nigeria outside the university system. The Board was established by the **National Board for Technical Education Act No. 9 of 1977**, with its powers further strengthened by the **Education (National Minimum Standards and Establishment of Institutions) Act (1985)** and its amendment in **1993 (1-5)**.

The policy mandate of NBTE includes the following:

1. Formulation and Coordination of TVET Policy

NBTE advises the Federal Government on all matters relating to technical and vocational education outside the university system. It coordinates national TVET policies to ensure they support Nigeria's economic development, industrialization, and workforce needs.

2. Regulation and Quality Assurance

The Board establishes and enforces minimum academic standards for polytechnics, monotechnics, technical colleges, colleges of agriculture, colleges of health technology, innovation enterprises, and other TVET institutions. It conducts accreditation, resource inspections, quality assurance audits, and compliance monitoring to ensure institutions meet national standards.

3. Curriculum Development

NBTE develops, reviews, and periodically updates competency-based curricula for National Diploma (ND), Higher National Diploma (HND), and other technical education programmes. These curricula are designed in collaboration with industry to ensure graduates possess relevant technical and employability skills.

4. Accreditation of Academic Programmes

The Board accredits programmes offered by TVET institutions before they admit students. Accreditation evaluates staffing, facilities, curriculum implementation, laboratories, workshops, governance, and funding to ensure compliance with national minimum standards.

5. National Manpower Planning

NBTE assesses Nigeria's middle-level technical manpower requirements in consultation with relevant agencies and industry stakeholders. It prepares strategic plans to guide the establishment, expansion, and rational development of technical institutions based on national skills needs.

6. Institutional Planning and Development

The Board advises governments on the establishment, expansion, and rationalization of polytechnics and other TVET institutions. It also determines programme carrying capacities and promotes balanced geographical distribution of technical education opportunities

7. Promotion of Industry-Relevant Skills

NBTE promotes competency-based education, entrepreneurship, industrial attachment, apprenticeship, and stronger collaboration between industry and educational institutions to improve graduate employability and national productivity.

8. Promotion of Research and Innovation

The Board encourages applied research, technology development, innovation, digital transformation, and commercialization of research outputs within Nigeria's TVET sector. It also supports partnerships with industry and international organizations to strengthen technical education.

9. Data Collection and Information Management

NBTE maintains national databases of accredited institutions and programmes, collects data on technical education, and provides evidence for educational planning and policy development.

10. Support for National Development

The Board's overarching mandate is to produce skilled technical and professional manpower required for Nigeria's industrialization, economic diversification, technological advancement, and sustainable national development. Its vision is to be a world-class regulatory body for TVET, while its mission is to promote the production of skilled technical and professional manpower for national development.

The STEM Transformation Strategy (2026–2036) is fully aligned with the NUC’s mandate to regulate, coordinate, and advance polytechnic and monotechnic education in Nigeria. By embedding STEM priorities into accreditation processes, policy frameworks, and institutional support mechanisms, the NBTE will play a pivotal role in ensuring that Nigerian polytechnics produce graduates who are globally competitive, nationally relevant, and capable of driving innovation-led growth.

1.6 Policy Mandate of the National Commission for Colleges of Education (NCCE), Nigeria

The **National Commission for Colleges of Education (NCCE)**[4] is the statutory regulatory agency responsible for the coordination, regulation, quality assurance, and development of **non-degree teacher education** in Nigeria. It was established by **Decree No. 3 of 1989** (amended by **Decree No. 12 of 1993**), now the **National Commission for Colleges of Education Act, Cap. N79, Laws of the Federation of Nigeria 2004**. The Commission is responsible for ensuring that Colleges of Education produce competent and professionally qualified teachers for Nigeria's basic education system.

The policy mandate of NCCE includes the following:

1. Formulation of Teacher Education Policy

The NCCE advises the Federal Government on all matters relating to teacher education outside the university and polytechnic systems. It develops policies that strengthen teacher preparation, professional standards, and the overall quality of Colleges of Education in line with the National Policy on Education.

2. Regulation and Quality Assurance

The Commission regulates all Colleges of Education offering the Nigeria Certificate in Education (NCE) and other approved teacher education programmes. It establishes minimum academic standards and monitors compliance to ensure high-quality teacher education nationwide.

3. Curriculum Development

NCCE develops, reviews, and periodically updates curricula for NCE programmes to ensure they remain relevant to national educational goals, emerging pedagogical practices, technological advancement, and labour market needs. The Commission promotes competency-based teacher education and digital learning.

4. Accreditation of Academic Programmes

The Commission accredits all teacher education programmes in Colleges of Education and other NCE-awarding institutions. Accreditation assesses curriculum implementation, staffing, teaching practice, infrastructure, laboratories, libraries, governance, and learning resources to ensure compliance with national standards.

5. Approval and Establishment of Colleges of Education

NCCE develops guidelines for establishing new Colleges of Education and evaluates proposals for federal, state, and private institutions. It advises the Federal Government on the approval and licensing of institutions and monitors compliance with prescribed standards.

[4] Federal Republic of Nigeria. (2004). National Commission for Colleges of Education Act, Cap. N79, Laws of the Federation of Nigeria 2004.

6. Institutional Planning and Development

The Commission coordinates the planned development of Colleges of Education by advising on enrolment capacity, infrastructure, staffing requirements, institutional expansion, and resource allocation to ensure balanced national growth in teacher education.

7. Teacher Professional Development

NCCE promotes continuous professional development for teacher educators through staff training, research, workshops, curriculum innovation, and collaboration with professional bodies and development partners. It also encourages effective teaching practice and improved teacher competence.

8. Research and Innovation

The Commission supports educational research, innovation in teacher preparation, digital transformation, and evidence-based policy development. It encourages partnerships with national and international organizations to strengthen teacher education and improve learning outcomes.

9. Funding and External Assistance

The NCCE advises the Federal Government on the funding requirements of Colleges of Education and serves as the coordinating agency for external grants, donor assistance, and international technical cooperation relating to teacher education.

10. Data Collection and Educational Planning

The Commission collects, analyzes, and publishes data on teacher education institutions, enrolment, staffing, programme quality, and educational outcomes. These data support evidence-based planning, monitoring, and policy formulation.
The STEM Transformation Strategy (2026–2036) is fully aligned with the NCCE's mandate to regulate, coordinate, and advance colleges of education in Nigeria. By embedding STEM priorities into accreditation processes, policy frameworks, and institutional support mechanisms, the NCCE will play a pivotal role in ensuring that Nigerian colleges of education graduates who are globally competitive, nationally relevant, and capable of driving innovation-led growth.

1.7 Policy Mandate of the Tertiary Education Fund (TETFUND)

The **Tertiary Education Trust Fund (TETFund)** is a Federal Government intervention agency established under the **Tertiary Education Trust Fund (Establishment, Etc.) Act, 2011**. It replaced the former Education Trust Fund (ETF) and is mandated to **administer, manage, and disburse the tertiary education tax** to public tertiary institutions in Nigeria. The Fund supports the rehabilitation, restoration, and consolidation of tertiary education by financing infrastructure, research, academic staff development, and institutional capacity building.[5]

[5] Federal Republic of Nigeria. (2011). Tertiary Education Trust Fund (Establishment, Etc.) Act, 2011.

The policy mandate of NCCE includes the following:

1. Management and Disbursement of Tertiary Education Tax

TETFund is responsible for administering and disbursing the tertiary education tax collected from eligible companies operating in Nigeria. The Fund ensures that these resources are allocated transparently and equitably to eligible public universities, polytechnics, and colleges of education.

2. Funding Physical Infrastructure

One of TETFund's primary mandates is to finance the construction, rehabilitation, renovation, and maintenance of critical educational infrastructure, including lecture theatres, laboratories, workshops, libraries, hostels, and administrative buildings. These interventions improve the teaching and learning environment across public tertiary institutions.

3. Provision of Teaching and Research Equipment

The Fund finances the acquisition of modern teaching equipment, laboratory facilities, ICT infrastructure, library resources, and instructional materials to improve the quality of education and research.

4. Promotion of Research and Innovation

TETFund supports research through institutional research grants, National Research Fund (NRF) grants, innovation funding, research commercialization, and multidisciplinary collaborative research that addresses national development priorities. It also promotes university–industry collaboration and knowledge transfer.

5. Academic Staff Training and Development

The Fund finances postgraduate studies, local and international scholarships, conference attendance, academic exchanges, manuscript development, and other professional development programmes aimed at improving the quality and productivity of academic staff.

6. Quality Improvement in Public Tertiary Education

TETFund provides intervention funding to improve educational quality through accreditation support, institutional strengthening, library development, curriculum enhancement, digital learning, and quality assurance initiatives.

7. Monitoring and Evaluation of Funded Projects

The Fund monitors and evaluates all approved projects to ensure timely implementation, accountability, transparency, value for money, and compliance with approved guidelines. Institutions are required to account for the utilization of intervention funds

CHAPTER TWO

SITUATIONAL ANALYSIS OF STEM IN NIGERIAN HIGHER EDUCATION

2.1 Overview of Universities, Polytechnics, and Colleges of Education

Introduction

Nigeria's higher education system is one of the largest in Africa and comprises universities, polytechnics, colleges of education, monotechnics, and specialized research and professional institutions. These institutions collectively support the country's human capital development agenda by producing skilled graduates, advancing scientific research, promoting technological innovation, and contributing to national socio-economic development. Each category of institution has a distinct mandate established through national legislation and regulated by relevant agencies, including the National Universities Commission (NUC), National Board for Technical Education (NBTE), and National Commission for Colleges of Education (NCCE).[6] While universities emphasize research and knowledge creation, polytechnics focus on technical and vocational education, and colleges of education prepare qualified teachers for the nation's education system.[7,8] Despite significant expansion in institutional numbers and enrolment, the sector continues to face challenges related to funding, infrastructure, quality assurance, graduate employability, digital transformation, and research competitiveness. Understanding the comparative strengths and challenges of each institutional type is essential for developing an integrated ICT-enabled STEM Transformation Strategy for Nigeria. Tables 2.1 and 2.2 give a comparative overview of situational analysis of STEM in higher education in Nigeria.

[6] Federal Republic of Nigeria. (2004). National Universities Commission Act, Cap. N81, Laws of the Federation of Nigeria; Federal Republic of Nigeria. (2004). National Commission for Colleges of Education Act, Cap. N79, Laws of the Federation of Nigeria 2004; Federal Republic of Nigeria. (1977). National Board for Technical Education Act No. 9 of 1977 (as amended).

[7] Federal Ministry of Education. (2022). National Policy on Science, Technology and Innovation. Federal Ministry of Education, Abuja, Nigeria.

[8] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.

Table 2.1: Comparative Overview of Higher Education Institutions in Nigeria

Institution Type	Mandate	Key Strengths	Role in STEM Development	Key Challenges
Universities (Federal, State and Private)	Deliver undergraduate and postgraduate education, conduct research, generate new knowledge, promote innovation, and provide community service.[9]	Strong research capacity; postgraduate education; international collaborations; multidisciplinary programmes; Centres of Excellence; innovation and entrepreneurship initiatives.	Produce scientists, engineers, health professionals, ICT experts, researchers, and innovators; undertake advanced STEM research; support national innovation systems; develop high-level human capital.	Underfunding, ageing infrastructure, inadequate laboratories, high student–staff ratios, brain drain, limited commercialization of research, weak university–industry collaboration, and digital infrastructure gaps[10]
Polytechnics	Provide technical, vocational, and professional education with emphasis on practical skills, applied technology, and middle-level manpower development.[11]	Strong industry orientation; practical and competency-based training; engineering technology; manufacturing; entrepreneurship; close links with industrial practice.	Train technologists, technicians, engineering technologists, ICT professionals, renewable energy specialists, and manufacturing personnel essential for industrialization.	Limited funding, obsolete workshops, inadequate equipment, lower societal recognition compared with universities, weak research funding, and limited progression opportunities for graduates.[12]
Colleges of Education	Train qualified teachers for basic and secondary education and strengthen educational research and pedagogy.[13]	Teacher preparation; curriculum development; educational research; pedagogical expertise; extensive national outreach.	Produce STEM teachers for primary and secondary schools; improve science and mathematics education; strengthen STEM pedagogy and teacher professional development.	Declining enrolment in science education, inadequate teaching laboratories, insufficient digital infrastructure, limited research capacity, and shortages of qualified STEM teacher educators.[14]

[9] Federal Republic of Nigeria. (2004). National Universities Commission Act, Cap. N81, Laws of the Federation of Nigeria; Federal Ministry of Education. (2022). Nigeria Education Sector Renewal Initiative (NESRI).
[10] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.
[11] Federal Republic of Nigeria. (1977). National Board for Technical Education Act No. 9 of 1977 (as amended).
[12] https://web.nbte.gov.ng/
[13] Federal Republic of Nigeria. (2004). National Commission for Colleges of Education Act, Cap. N79, Laws of the Federation of Nigeria 2004.
[14] UNESCO. (2024). Designing and Implementing All-Day Schooling: Case Studies and Policy Lessons. Paris: UNESCO.

Table 2.1 (continued)

Institution Type	Mandate	Key Strengths	Role in STEM Development	Key Challenges
Monotechnics and Specialized Institutions	Provide specialized professional education in agriculture, health sciences, forestry, fisheries, aviation, petroleum, mining, environmental management, and other technical fields.[15]	Highly specialized programmes; strong practical orientation; close alignment with sector-specific workforce needs; professional certification.	Develop specialized technical expertise supporting agriculture, energy, mining, environmental sustainability, aviation, and health sectors.	Limited infrastructure, inadequate funding, fragmented governance, insufficient research capacity, and limited interdisciplinary collaboration.
Research Institutes	Conduct strategic research, technology development, policy research, and innovation in priority sectors such as agriculture, health, energy, environment, industry, and natural resources (Federal Ministry of Innovation, Science and Technology, 2022).	Specialized scientific expertise; applied research; national laboratories; technology development; policy support; international collaborations.	Generate scientific knowledge; develop indigenous technologies; support commercialization; provide technical support for universities and industry.	Limited commercialization of research, inadequate funding, ageing equipment, weak university–industry linkages, and limited private-sector investment.
Open and Distance Learning Institutions	Expand access to higher education through flexible, technology-enabled and lifelong learning.[16]	Flexible delivery; nationwide access; digital learning; continuing education; lifelong learning opportunities.	Expand access to STEM education through online learning, digital laboratories, virtual classrooms, and professional upskilling.	Digital divide, limited virtual laboratory infrastructure, internet connectivity challenges, student engagement, and practical laboratory delivery for STEM courses.
Private Higher Education Institutions	Complement public higher education through teaching, research, innovation, and workforce development while expanding access.[17]	Stable academic calendars; relatively modern facilities; smaller class sizes; flexible governance; rapid curriculum innovation.	Produce STEM graduates; invest in ICT infrastructure; foster entrepreneurship, innovation, and industry-responsive programmes.	High tuition costs, limited research funding, fewer postgraduate programmes, limited advanced research infrastructure, and restricted access for low-income students.

[15] Federal Ministry of Education. (2022). National Policy on Science, Technology and Innovation. Federal Ministry of Education, Abuja, Nigeria.
[16] Federal Ministry of Education. (2021). National Policy on Information and Communication Technology (ICT) in Education. Federal Ministry of Education, Abuja, Nigeria.
[17] National Universities Commission. (2023). Annual University System Report.

Table 2.2: Comparative Summary of the Overview of Higher Education Institutions in Nigeria

Institution Type	Primary Focus	Major STEM Contribution	Strategic Priority for ICT-STEM Transformation
Universities	Research, innovation, postgraduate education	Advanced scientific research, innovation, doctoral education, technology development	Research excellence, AI, digital transformation, innovation ecosystems, commercialization
Polytechnics	Applied technology and technical education	Engineering technology, manufacturing, technical workforce development	Industry 4.0, smart manufacturing, digital fabrication, advanced technical skills
Colleges of Education	Teacher education	STEM teacher preparation, science education, mathematics education	Digital pedagogy, teacher capacity building, STEM curriculum modernization
Monotechnics	Specialized professional education	Sector-specific technical workforce	Modern laboratories, specialized equipment, industry partnerships
Research Institutes	Scientific research and innovation	National R&D, technology transfer, policy support	National research infrastructure, commercialization, collaborative innovation
Open and Distance Learning	Flexible learning	Digital STEM education and lifelong learning	Online laboratories, AI-enabled learning, virtual experimentation
Private Institutions	Complementary higher education provision	Graduate production, innovation, entrepreneurship	Research partnerships, digital campuses, private investment in STEM

Table 2.3: Key findings on Overview of Universities, Polytechnics, and Colleges of Education

Area	Observation
Institutional Diversity	Nigeria possesses a diverse higher education ecosystem capable of supporting education, research, innovation, and workforce development.
Research Capacity	Universities and research institutes remain the primary drivers of scientific research and innovation.
Technical Skills Development	Polytechnics are central to producing technicians, technologists, and applied engineering professionals required for industrialization.
Teacher Development	Colleges of education remain indispensable for strengthening STEM education at the foundational levels of the education system.
Digital Transformation	All institutional categories require substantial investment in digital infrastructure, AI, virtual laboratories, and digital skills development.
Collaboration	Stronger collaboration among universities, polytechnics, colleges, research institutes, and industry is needed to strengthen the national innovation ecosystem.

The situational analysis reveals that while universities, polytechnics, and colleges of education each contribute uniquely to STEM development, fragmentation, resource constraints, and systemic inequities undermine their collective impact.

Strategic Implications

For the STEM Transformation Strategy (2026–2036) to succeed, reforms must:

1. Strengthen universities as hubs of research and innovation.
2. Modernize polytechnics to align technical training with industry needs.
3. Enhance colleges of education to ensure a pipeline of qualified STEM teachers.

4. Clarify and strengthen institutional mandates to reduce unnecessary duplication while promoting specialization and institutional differentiation.[18]
5. Develop an integrated national STEM ecosystem that promotes collaboration among universities, polytechnics, colleges of education, research institutes, industry, and government agencies.
6. Strengthen articulation pathways to facilitate student mobility between polytechnics, colleges of education, and universities through credit transfer and qualifications frameworks.
7. Increase investment in STEM infrastructure, digital technologies, research laboratories, and smart learning environments across all institutional categories.
8. Expand university–industry partnerships to improve graduate employability, applied research, entrepreneurship, and technology commercialization.
9. Strengthen institutional quality assurance systems through outcome-based education, competency-based curricula, and graduate tracking mechanisms.
10. Promote performance-based funding linked to institutional mandates, research productivity, graduate outcomes, innovation performance, and regional development priorities.
11. Support digital transformation by establishing national digital learning platforms, AI-enabled teaching systems, virtual laboratories, and integrated higher education management information systems.
12. Strengthen governance coordination among the NUC, NBTE, NCCE, TETFund, and relevant ministries to improve policy coherence and resource allocation.

Together, these institutions must be integrated into a coherent national STEM ecosystem that supports Nigeria's demographic and economic transformation. For the STEM Transformation Strategy (2026–2036) to succeed, reforms must be coordinated across all three institution types. Universities must drive innovation and global competitiveness; polytechnics must strengthen technical capacity and industry readiness; colleges of education must ensure a pipeline of qualified STEM teachers to sustain foundational learning. Together, they form a complementary ecosystem essential for Nigeria's demographic and economic transformation.

2.2 STEM Enrolment, Retention, and Graduation Trends

Introduction

The performance of Nigeria's higher education system in STEM fields reflects both progress and persistent challenges. Enrolment has grown steadily, but retention and graduation rates remain uneven, undermining the country's ability to produce a globally competitive STEM workforce. The Table 2.4 below provides a synthesis of current evidence on STEM enrolment, retention, and graduation in Nigeria's higher education system. Since Nigeria does not yet maintain a centralized national STEM student tracking database, several indicators are based on trends consistently reported by the National Universities Commission, Joint Admissions and Matriculation Board, National Board for Technical Education, UNESCO Institute for Statistics, and published academic studies rather than complete national cohort statistics.[19,20,21,22]

[18] Federal Ministry of Education. (2022). Nigeria Education Sector Renewal Initiative (NESRI).
[19] National Universities Commission (2023). Annual University Statistics.
[20] Joint Admissions and Matriculation Board (2024). Unified Tertiary Matriculation Examination (UTME) Annual Statistics.
[21] National Board for Technical Education (2023). TVET and Polytechnic Education Statistics.
[22] UNESCO Institute for Statistics (2024). Education Database.

Table 2.4: Analysis of STEM enrolment, Retention and Graduation Trend in Higher Education

Indicator	Trend	Status	Implications
Overall STEM Enrolment	**Increasing** due to growing demand for technology, healthcare, engineering, and digital economy careers.	Applications to STEM programmes continue to rise, particularly in engineering, medicine, computer science, pharmacy, and allied health sciences. However, admission capacity remains insufficient, and Nigeria's gross tertiary enrolment rate remains below the global average.	Rising demand presents opportunities for economic transformation but requires significant expansion of infrastructure, laboratories, qualified faculty, and funding.
Discipline Disparity in STEM Enrolment	**Widening imbalance** across STEM disciplines. Students increasingly favour medicine, computer science, engineering, pharmacy, and information technology, while enrolment in chemistry, physics, mathematics, geology, agricultural sciences, statistics, and environmental sciences has remained relatively stagnant or declined in many institutions.	Highly competitive programmes such as medicine, nursing, engineering, and computer science receive far more applicants than available spaces, whereas many foundational science programmes struggle to attract sufficient enrolment despite their importance for research, innovation, education, and industrial development.	The imbalance threatens the sustainability of Nigeria's scientific research ecosystem by creating shortages of scientists, science teachers, laboratory researchers, and specialists in strategic sectors such as agriculture, energy, manufacturing, mining, and environmental management. Policy incentives, scholarships, career awareness programmes, and improved employment pathways are needed to encourage enrolment in under-subscribed STEM disciplines.
Female STEM Enrolment	**Gradually improving**, although disparities remain pronounced in engineering, computing, mathematics, and physical sciences.	Female representation has increased in biological and health sciences but remains relatively low in engineering, technology, and ICT programmes.	Greater gender equity would expand Nigeria's STEM talent pool, strengthen innovation, and contribute to inclusive economic growth.
STEM Student Retention	**Moderate**, with persistent challenges affecting student progression.	Financial hardship, inadequate laboratories, industrial actions, poor academic preparation, and weak student support systems contribute to attrition, particularly during the first and second years of STEM programmes.	Improving student retention would increase graduation rates, reduce institutional inefficiencies, and strengthen the national STEM workforce.
STEM Graduation Rates	**Gradually increasing**, although completion times have lengthened.	Expansion of tertiary institutions has increased the number of STEM graduates, but many students experience delayed graduation due to strikes, infrastructure deficits, and limited laboratory access.	Delayed graduation reduces workforce availability and increases the cost of higher education for both students and government.

Table 2.4 (continued)

Indicator	Trend	Status	Implications
Quality of STEM Graduates	**Mixed**. Graduate numbers are increasing faster than improvements in quality.	Employers continue to identify gaps in practical laboratory skills, digital competencies, innovation capacity, entrepreneurship, and problem-solving abilities among many STEM graduates.	Curriculum modernization, competency-based education, experiential learning, and stronger industry collaboration are needed to improve graduate employability.
Regional and Institutional Disparities	**Persistent** across geopolitical zones and institution types.	Federal universities generally possess stronger STEM infrastructure and research capacity than many state institutions and colleges, while significant regional disparities in access remain.	Unequal educational opportunities contribute to regional differences in innovation capacity and skilled workforce development.
Technical and Vocational STEM Education (TVET)	**Growing policy attention**, but enrolment remains relatively low.	Despite government initiatives to strengthen Technical and Vocational Education and Training (TVET), enrolment in polytechnics and technical colleges remains below national industrial workforce requirements.	Strengthening TVET is essential for producing technicians, technologists, and skilled professionals needed for industrialization and manufacturing.
Graduate Employability	**Improving in ICT-related disciplines**, while remaining uneven across traditional STEM fields.	Graduates with skills in artificial intelligence, software engineering, cybersecurity, renewable energy, and data science experience stronger employment prospects than graduates in some conventional science disciplines.	Universities should strengthen labour market alignment, entrepreneurship education, internships, and industry partnerships to improve graduate outcomes across all STEM fields.

The key insight from the above analysis is presented in Table 2.5. The evidence suggests that Nigeria's STEM challenge is **not only increasing enrolment but also achieving a balanced distribution across STEM disciplines**. While high-demand professional programmes such as medicine, engineering, nursing, pharmacy, and computer science attract most applicants, foundational sciences—including chemistry, physics, mathematics, agricultural sciences, geology, environmental sciences, and statistics—remain under-enrolled. These disciplines underpin scientific research, teacher preparation, industrial innovation, and national technological development. Addressing these disparities will require targeted scholarships, career guidance, curriculum modernization, improved research funding, stronger university–industry partnerships, and labour market incentives.

Table 2.5: Key findings on STEM enrolment, Retention and Graduation Trend in Higher Education

Area	Summary
Enrolment	Increasing demand for STEM education, but institutional capacity has not kept pace.
Retention	Moderate retention, constrained by financial barriers, inadequate infrastructure, and institutional disruptions.
Graduation	Increasing numbers of graduates, but delayed completion remains common.
Gender	Female participation is improving but remains uneven across STEM disciplines.
Quality	Expansion in enrolment has outpaced investments in laboratories, equipment, and academic staffing.
Labour Market	Strong demand exists for graduates with digital, engineering, renewable energy, and innovation-related skills.

Strategic Policy Implications

The analysis reveals that while enrolment in STEM is increasing, retention and graduation remain fragile. Without deliberate reforms, Nigeria risks producing insufficient numbers of skilled graduates to meet national development needs. The STEM Transformation Strategy (2026–2036) must therefore prioritize:

1. Expanding infrastructure and digital learning platforms.
2. Strengthening faculty development and retention.
3. Implementing gender equity programs to boost female participation in underrepresented fields.
4. Expanding STEM admission capacity through investment in laboratories, classrooms, and digital infrastructure.
5. Improving student retention via scholarships, mentoring, academic advising, and psychosocial support.
6. Reducing graduation delays by improving institutional stability, infrastructure, and programme management.
7. Strengthening university–industry partnerships to enhance practical skills and graduate employability.
8. Establishing a national STEM education data system to track enrolment, retention, completion, employment outcomes, and workforce demand across universities, polytechnics, and colleges.

2.3 Infrastructure and Laboratory Deficits

Introduction

The quality of STEM education and research in Nigeria is closely linked to the availability of modern physical infrastructure, laboratories, digital technologies, and research facilities. Although the country's higher education sector has expanded significantly over the past two decades, infrastructure development has not kept pace with increasing student enrolment and the growing demand for high-quality STEM education. Table 2.6 highlights the trend, status and implications. Chronic underinvestment, inadequate maintenance, obsolete laboratory equipment, unreliable electricity supply, limited digital infrastructure, and insufficient research facilities continue to constrain teaching, learning, innovation, and knowledge production. These challenges undermine Nigeria's ability to produce globally competitive graduates,

conduct frontier research, and achieve its aspirations under the national digital economy and industrialization agendas. Addressing these infrastructure deficits is therefore a strategic priority for strengthening STEM education, improving research quality, and fostering innovation-led economic development.[23,24] Table 2.7 shows the overall trend.

Table 2.6: Analysis of Infrastructure and Laboratory Deficits in Nigeria's Higher Education System

Indicator	Trend	Status	Implications
Teaching and Learning Infrastructure	**Demand far exceeds capacity** due to rapid expansion in student enrolment.	Many universities, polytechnics, and colleges operate overcrowded lecture theatres, inadequate classrooms, limited office space, and insufficient learning facilities. Infrastructure expansion has lagged enrolment growth.	Overcrowding reduces teaching effectiveness, limits active learning, lowers student satisfaction, and affects educational quality.
Science and Engineering Laboratories	**Persistent laboratory deficit** with slow modernization.	Many laboratories rely on obsolete equipment, inadequate instrumentation, insufficient laboratory consumables, and outdated experimental facilities. Advanced scientific equipment is concentrated in relatively few institutions.	Poor laboratory facilities reduce practical learning, limit experimental research, and weaken graduate competencies in STEM disciplines.
Research Infrastructure	**Gradual improvement**, but investment remains insufficient.	Access to advanced research facilities including analytical laboratories, pilot plants, shared instrumentation, research farms, and specialized research centres remains limited and uneven across institutions.	Limited research infrastructure constrains scientific productivity, innovation, commercialization, and international research competitiveness.
Digital Infrastructure and ICT Facilities	**Improving gradually**, but significant digital gaps remain.	Many institutions experience inadequate broadband connectivity, unreliable campus internet, insufficient computer laboratories, limited digital libraries, and underdeveloped learning management systems.	Digital deficiencies hinder online learning, artificial intelligence applications, computational research, virtual laboratories, and digital skills development.
Electricity and Utility Infrastructure	**Persistent challenge** across many institutions.	Frequent electricity outages, unreliable water supply, and inadequate backup power systems disrupt laboratory experiments, ICT services, and research activities.	Utility deficiencies increase operational costs, damage sensitive scientific equipment, delay experiments, and reduce research productivity.
Laboratory Equipment Availability	**Equipment deficit widens** as technology evolves rapidly.	Numerous departments lack essential scientific instruments, while existing equipment is often outdated, poorly calibrated, or non-functional due to age and inadequate maintenance.	Students receive limited exposure to modern instrumentation, reducing research quality, employability, and innovation capacity.

[23] UNESCO Institute for Statistics (2024). Education Database.
[24] World Bank (2024). World Development Indicators: Education and Skills.

Equipment Maintenance and Technical Support	**Weak maintenance culture** persists.	Preventive maintenance is often inadequate due to limited maintenance budgets, shortages of trained laboratory technologists, and difficulty obtaining spare parts. Equipment downtime remains high.	Poor maintenance reduces equipment lifespan, increases replacement costs, and limits utilization of expensive research infrastructure.
Shared Research Infrastructure	**Limited but expanding** through Centres of Excellence and donor-supported initiatives.	High-value scientific equipment is concentrated in a small number of institutions, with no comprehensive national equipment-sharing framework to maximize utilization.	Duplication of costly equipment reduces efficiency while limiting access for researchers in less-resourced institutions.
Engineering Workshops and Technical Training Facilities	**Modernization remains inadequate.**	Engineering workshops, fabrication laboratories, and technical training facilities in many universities and polytechnics still utilize obsolete machinery that does not reflect current industrial technologies.	Graduates may lack industry-relevant practical competencies required for advanced manufacturing, renewable energy, construction, and industrial automation.
Innovation, Incubation and Prototyping Facilities	**Growing policy emphasis**, but institutional coverage remains limited.	Innovation hubs, makerspaces, fabrication laboratories, technology incubation centres, and entrepreneurship laboratories exist in selected institutions but remain insufficient nationally.	Limited innovation infrastructure constrains technology commercialization, startup development, patent generation, and university-industry collaboration.
Infrastructure Equity Across Institutions	**Persistent disparities** across institution types and regions.	Federal universities generally possess stronger infrastructure than many state universities, polytechnics, and colleges of education, while institutions in underserved regions face larger infrastructure deficits.	Unequal infrastructure contributes to regional disparities in educational quality, research productivity, and innovation capacity.
Laboratory Safety and Environmental Compliance	**Improving slowly**, but implementation remains inconsistent.	Many laboratories require improvements in chemical storage, ventilation systems, emergency response facilities, personal protective equipment, hazardous waste management, and compliance with international laboratory standards.	Weak laboratory safety poses risks to students and staff, limits accreditation opportunities, and reduces international research collaboration.

Table 2.7: Key overall Trend

Area	Summary
Physical Infrastructure	Expansion has not kept pace with rapidly increasing student enrolment.
Laboratory Facilities	Many STEM laboratories require modernization, equipment replacement, and regular maintenance.
Research Infrastructure	Advanced research facilities remain insufficient and unevenly distributed across institutions.
Digital Infrastructure	ICT capacity is improving but still falls short of the requirements for digital learning and research-intensive universities.
Utilities	Unreliable electricity and water supply continue to undermine laboratory operations and research productivity.
Innovation Infrastructure	Innovation hubs and incubation centres are increasing but remain insufficient to support a national innovation ecosystem.
Equity	Significant disparities persist between federal and state institutions and across geopolitical zones.

Strategic Policy Implications

The evidence indicates that infrastructure deficiencies have become one of the principal constraints to Nigeria's STEM transformation. Strategic investments should therefore prioritize:

1. Expansion and modernization of STEM classrooms, laboratories, workshops, and research facilities.
2. Establishment of a **National Shared Research Infrastructure Network** to improve access to high-value scientific equipment across institutions.
3. Sustainable laboratory equipment maintenance systems, including lifecycle management, technical support personnel, and dedicated maintenance budgets.
4. Investment in reliable broadband connectivity, digital learning platforms, renewable energy systems, and uninterrupted power supply.
5. Expansion of innovation ecosystems through makerspaces, technology incubation centres, engineering design studios, and fabrication laboratories.
6. Targeted infrastructure funding to reduce disparities between federal, state, and private institutions and across geopolitical zones.
7. Strengthening laboratory safety systems and quality assurance through adoption of international standards and accreditation frameworks.

2.4 Faculty Capacity and Skills Gaps

Introduction

Faculty quality is the cornerstone of a high-performing higher education system and a critical determinant of STEM education outcomes, research productivity, and innovation. Nigeria has made considerable progress in expanding access to tertiary education over the past two decades, but growth in student enrolment has significantly outpaced the recruitment, development, and retention of qualified academic staff. Many institutions face shortages of faculty in STEM disciplines, aging academic workforces, inadequate opportunities for

continuous professional development (CPD), limited exposure to emerging technologies, and weak industry engagement. In addition, the increasing demand for competencies in artificial intelligence (AI), data science, advanced manufacturing, renewable energy, biotechnology, digital pedagogy, and interdisciplinary research has created new skills requirements that many academic staff have not yet acquired. The analysis of Faculty capacity and skills gaps in presented in Table 2.8 while Table 2.9 provides the overall trend. Addressing faculty capacity and skills gaps is therefore fundamental to improving teaching quality, strengthening research and innovation, enhancing graduate employability, and achieving Nigeria's aspirations for a knowledge-based economy.[25,26]

Table 2.8: Analysis of Faculty Capacity and Skills Gaps in Nigeria's Higher Education System

Indicator	Trend	Status	Implications
Academic Staff Availability	**Faculty shortages are increasing** as student enrolment grows faster than recruitment.	Many universities, polytechnics, and colleges experience shortages of qualified academic staff, particularly in engineering, computing, health sciences, artificial intelligence, mathematics, and emerging STEM disciplines. Student-to-faculty ratios in many institutions exceed recommended benchmarks.	High teaching loads reduce instructional quality, limit student mentoring, and constrain research productivity.
Faculty Qualifications	**Gradual improvement**, but doctoral-level capacity remains inadequate.	Although the number of PhD-qualified academics has increased, many departments continue to rely on lecturers without doctoral qualifications, particularly in newer universities and polytechnics.	Limited doctoral capacity affects postgraduate supervision, research quality, curriculum development, and institutional accreditation.
Age Profile of Academic Staff	**Aging professoriate** with slow replacement of senior academics.	A significant proportion of senior professors are approaching retirement, while recruitment of early-career academics has not kept pace. Succession planning remains weak in many institutions.	Loss of institutional knowledge and research leadership may reduce academic excellence unless succession pipelines are strengthened.
Continuous Professional Development (CPD)	**Growing recognition**, but implementation remains inconsistent.	Opportunities for pedagogical training, digital skills development, curriculum innovation, research management, and leadership development vary considerably across institutions and are often dependent on donor-funded projects.	Limited CPD reduces teaching effectiveness, slows curriculum modernization, and weakens institutional adaptability to technological change.
Digital and Emerging Technology Skills	**Skills gap widening** as technological change accelerates.	Many academic staff have limited expertise in artificial intelligence, machine learning, data analytics, cybersecurity, cloud computing, computational modelling, digital laboratories, and educational technologies.	Graduates may lack industry-relevant digital competencies, reducing national competitiveness in the digital economy.

[25] UNESCO Institute for Statistics (2024). Education Database.
[26] World Bank (2024). World Development Indicators: Education and Skills.

Research Capacity	**Growing research output**, but uneven research capability.	Many academics face challenges related to research funding, laboratory access, international collaboration, grant writing, scientific publishing, and research commercialization.	Weak research capacity limits innovation, international visibility, technology transfer, and contribution to national development priorities.
Industry Experience and Engagement	**Limited university–industry mobility**.	Many faculty members have limited industrial experience and relatively few opportunities for industrial attachments, collaborative research, consultancy, or professional practice.	Curricula may become disconnected from labour market needs, reducing graduate employability and innovation potential.
Pedagogical Competence	**Transition toward learner-centred education**, but adoption remains uneven.	Traditional lecture-based teaching continues to dominate in many institutions despite increasing emphasis on project-based learning, experiential education, problem-based learning, digital pedagogy, and competency-based education.	Outdated teaching methods reduce student engagement, critical thinking, creativity, and practical problem-solving skills.
International Collaboration and Mobility	**Increasing gradually**, but participation remains limited.	Opportunities for faculty exchanges, visiting scholarships, international research collaborations, and participation in global research networks remain concentrated in relatively few institutions.	Limited global engagement reduces knowledge exchange, research quality, access to funding, and international competitiveness.
Gender Balance in Academic Staff	**Improving slowly**, but disparities remain significant.	Women remain underrepresented among STEM faculty, particularly in engineering, computer science, mathematics, physics, and senior academic leadership positions.	Increasing gender diversity would strengthen research excellence, mentorship opportunities, and inclusive innovation ecosystems.
Academic Staff Retention	**Retention challenges increasing** due to economic pressures and international migration.	Competitive global demand for highly skilled academics has contributed to brain drain, while relatively low remuneration, limited research funding, and constrained career progression affect retention.	Loss of experienced faculty weakens institutional capacity, increases recruitment costs, and reduces research continuity.
Technical and Laboratory Support Staff	**Persistent shortage of skilled technical personnel**.	Many institutions have inadequate numbers of laboratory technologists, research technicians, instrumentation specialists, and ICT support personnel.	Insufficient technical support reduces laboratory utilization, equipment maintenance, practical teaching quality, and research efficiency.

Table 2.9: Key overall trend

Area	Summary
Faculty Numbers	Recruitment has not kept pace with expanding student enrolment.
Faculty Quality	Doctoral qualifications are improving but remain insufficient in many institutions and disciplines.
Digital Skills	Significant gaps exist in AI, data science, digital technologies, and emerging STEM fields.
Research Capacity	Research productivity is increasing, but funding, infrastructure, and commercialization remain major constraints.
Teaching Skills	Greater adoption of learner-centred and technology-enabled pedagogies is required.
Industry Linkages	Faculty engagement with industry remains relatively weak.
Brain Drain	Increasing migration of highly qualified academics threatens institutional sustainability.
Technical Support	Shortages of laboratory technologists and research support staff constrain STEM education and research.

Strategic Policy Implications

To strengthen faculty capacity and address emerging skills gaps, Nigeria's ICT-enabled STEM transformation strategy should prioritize:

1. **Recruitment of additional STEM faculty**, particularly in engineering, computer science, artificial intelligence, mathematics, renewable energy, biotechnology, and health sciences.
2. **Expansion of doctoral education** through competitive scholarships, postdoctoral fellowships, and structured academic career pathways.
3. **Institutionalization of Continuous Professional Development (CPD)** in digital pedagogy, AI, curriculum design, research methods, leadership, and innovation management.
4. **Strengthening university–industry partnerships** through industrial attachments, joint research programmes, faculty exchanges, consultancy, and professional certification.
5. **Development of national digital competency frameworks** for higher education faculty to support the integration of AI, data science, simulation tools, virtual laboratories, and online learning.
6. **Improvement of academic staff retention** through competitive remuneration, enhanced research funding, transparent promotion systems, and improved working conditions.
7. **Investment in technical support personnel**, including laboratory technologists, instrumentation engineers, ICT specialists, and research management professionals.
8. **Promotion of gender equity** in STEM faculty recruitment, leadership, mentoring, and career advancement.
9. **Expansion of international collaboration** through faculty mobility programmes, joint doctoral supervision, international research partnerships, and participation in global research networks.

2.5 Research Productivity and Innovation Performance

Introduction

Research and innovation are fundamental to building a knowledge-based economy, improving industrial competitiveness, and addressing national development challenges. Universities, polytechnics, and research institutes play a central role in generating scientific knowledge, developing new technologies, supporting evidence-based policymaking, and producing highly skilled human capital. Over the past decade, Nigeria has recorded a steady increase in scientific publications and international research collaborations, supported by investments from the Tertiary Education Trust Fund (TETFund), international development partners, and expanding postgraduate education. However, research productivity remains constrained by inadequate funding, obsolete research infrastructure, limited commercialization of research outputs, weak university–industry collaboration, low patenting activity, fragmented innovation ecosystems, and insufficient incentives for high-impact research (Table 2.10 and 11). Strengthening research productivity and innovation performance is therefore essential for achieving Nigeria's aspirations for economic diversification, industrialization, digital transformation, and sustainable development.[27,28]

Table 2.10: Analysis of Research Productivity and Innovation Performance in Nigeria's Higher Education System

Indicator	Trend	Status	Implications
Scientific Publications	**Steady increase** in publication output over the past decade.	Nigerian universities produce an increasing number of peer-reviewed publications, particularly in health sciences, agriculture, engineering, environmental sciences, and chemistry. However, publication productivity varies considerably among institutions and disciplines.	Growing publication output enhances scientific visibility but requires greater emphasis on research quality, citation impact, and societal relevance.
Research Quality and Citation Impact	**Improving gradually**, but citation impact remains below global averages in many disciplines.	Although publication volumes are increasing, relatively few publications appear in high-impact journals or receive substantial international citations.	Improving research quality is necessary to enhance global competitiveness, university rankings, and international collaborations.
Research Funding	**Increasing modestly**, but remains below international benchmarks.	Government funding through TETFund has expanded research support, but overall expenditure on research and development remains below the African Union target of 1% of GDP and significantly below levels in leading innovation economies.	Insufficient funding limits research scope, equipment acquisition, multidisciplinary collaboration, and long-term scientific programmes.
Research Infrastructure	**Gradual improvement**, but	Many institutions continue to face shortages of modern	Infrastructure deficits constrain high-quality

[27] UNESCO Institute for Statistics (2024). Education Database.
[28] World Bank (2024). World Development Indicators: Education and Skills.

	significant deficits remain.	laboratories, advanced instrumentation, research software, high-performance computing facilities, and digital research infrastructure.	research, technology development, and international competitiveness.
Postgraduate Research Capacity	**Growing steadily** due to expansion of postgraduate programmes.	Master's and doctoral enrolments have increased, but supervision capacity, laboratory facilities, research funding, and timely completion remain major challenges.	Strengthening postgraduate education is essential for developing future researchers, innovators, and academic leaders.
International Research Collaboration	**Increasing significantly**.	Nigerian researchers participate in a growing number of international collaborative projects supported by global funding agencies and research networks. However, participation is concentrated in a relatively small number of universities.	International collaboration improves research quality, access to funding, scientific visibility, and knowledge transfer.
University–Industry Collaboration	**Improving slowly**, but remains relatively weak.	Collaboration between higher education institutions and industry is largely limited to consultancy services, internships, and isolated joint research projects. Long-term strategic partnerships remain uncommon.	Weak collaboration reduces research commercialization, industrial innovation, and graduate employability.
Innovation and Technology Commercialization	**Emerging**, but commercialization remains limited.	Although universities increasingly establish innovation hubs, entrepreneurship centres, and technology transfer offices, relatively few research outputs progress to commercialization or market deployment.	Limited commercialization reduces the economic and societal impact of publicly funded research and innovation.
Patent Applications and Intellectual Property (IP)	**Gradual increase**, but overall patenting activity remains low.	Nigerian universities generate relatively few patents, utility models, and technology licenses compared with research output. Awareness of intellectual property management is improving but remains uneven.	Low patenting limits technology transfer, private sector investment, and revenue generation from university research.
Research in Emerging Technologies	**Growing rapidly**, especially in AI, biotechnology, renewable energy, and digital technologies.	Increasing numbers of researchers are engaging in interdisciplinary research on artificial intelligence, climate change, clean energy, data science, precision agriculture, and biotechnology, although institutional capacity varies considerably.	Expanding research in emerging technologies will strengthen Nigeria's competitiveness in future industries and the Fourth Industrial Revolution.
Innovation Ecosystem	**Developing**, but fragmented.	Innovation hubs, incubation centres, fabrication laboratories, and startup ecosystems are expanding, particularly in major	Stronger innovation ecosystems would accelerate technology transfer, entrepreneurship, and job creation.

		universities, but national coordination remains limited.	
Research Governance and Management	**Receiving greater attention**, but institutional capacity remains uneven.	Many institutions have established research offices, ethics committees, and grant management units; however, research administration, monitoring, evaluation, and impact assessment remain underdeveloped.	Improved research governance would increase grant success, accountability, research quality, and institutional effectiveness.
Societal and Policy Impact of Research	**Increasing recognition**, but translation into policy and practice remains inconsistent.	Research findings are not consistently translated into public policy, industrial practice, or community innovation due to weak science-policy and university-industry interfaces.	Strengthening knowledge translation mechanisms would maximize the developmental impact of research investments.

Table 2.11: Key Trends

Area	Summary
Research Output	Scientific publications are increasing, but quality and citation impact require further improvement.
Research Funding	Investment has increased but remains below levels needed to support globally competitive research.
Research Infrastructure	Modern laboratories, scientific equipment, and digital research facilities remain inadequate in many institutions.
Innovation	Innovation ecosystems are emerging, but commercialization and technology transfer remain limited.
Industry Collaboration	Partnerships between academia and industry remain relatively weak and fragmented.
Intellectual Property	Patent generation and IP commercialization remain low relative to research output.
Emerging Technologies	Research activity in AI, renewable energy, biotechnology, and digital technologies is expanding rapidly.
Research Governance	Institutional research management systems are improving but require further strengthening.

Strategic Policy Implications

The STEM transformation strategy is to enhance research productivity and innovation performance, prioritizing:

1. **Increasing national investment in research and development (R&D)** to at least **1% of GDP**, consistent with the **African Union's** recommendation.
2. **Modernizing research infrastructure**, including advanced laboratories, high-performance computing, digital repositories, and shared national research facilities.
3. **Strengthening postgraduate education** through increased doctoral scholarships, research fellowships, and postdoctoral programmes.
4. **Expanding competitive research funding**, particularly for interdisciplinary, challenge-driven, and industry-oriented research.

5. **Strengthening university–industry collaboration** through joint research centres, industrial PhD programmes, collaborative innovation grants, and co-funded research initiatives.
6. **Enhancing technology transfer and commercialization** by strengthening technology transfer offices, intellectual property management systems, startup incubators, and science parks.
7. **Supporting research in strategic priority areas**, including artificial intelligence, biotechnology, renewable energy, climate resilience, advanced manufacturing, digital agriculture, materials science, and health technologies.
8. **Building research management capacity** through professional grant administration, research ethics, monitoring and evaluation, and impact assessment.
9. **Promoting international collaboration** by increasing participation in global research networks, mobility programmes, and multinational research consortia.
10. **Strengthening science-policy interfaces** to ensure that research findings inform public policy, industrial development, and evidence-based decision-making.

2.6 Funding Patterns and Budgetary Constraints

Introduction

Sustainable financing is fundamental to the quality, accessibility, and competitiveness of higher education. In Nigeria, the rapid expansion of universities, polytechnics, and colleges of education has significantly increased demand for financial resources to support teaching, research, digital transformation, infrastructure development, faculty development, and innovation. However, public investment in higher education has not kept pace with enrolment growth, resulting in persistent funding gaps that affect institutional performance. Government allocations remain the principal source of financing for public institutions, supplemented by interventions from the Tertiary Education Trust Fund (TETFund), internally generated revenue (IGR), research grants, donor agencies, and private sector partnerships. Nevertheless, recurrent expenditure continues to dominate institutional budgets, leaving inadequate resources for capital investment, research, laboratory modernization, digital infrastructure, and innovation Table 2.12 and 13). These financing challenges constrain Nigeria's ability to build globally competitive higher education institutions capable of supporting national industrialization, digital transformation, and sustainable economic growth.[29]

[29] UNESCO Institute for Statistics (2024). Education Database & World Bank (2024). World Development Indicators: Education and Skills.

Table 2.12: Analysis of Funding Patterns and Budgetary Constraints

Indicator	Trend	Status	Implications
Government Funding	**Increasing in nominal terms**, but declining in real value due to inflation and expanding enrolment.	Federal and state governments remain the principal financiers of public higher education. However, budgetary allocations have generally not kept pace with inflation, enrolment growth, and institutional expansion (Federal Ministry of Education, 2022; World Bank, 2024).	Resource shortages limit infrastructure expansion, laboratory modernization, faculty recruitment, digital transformation, and research capacity.
Education Budget Allocation	**Relatively low** compared with international aspirations and regional benchmarks.	Nigeria's public expenditure on education has remained below the UNESCO indicative benchmark of allocating **15–20% of total public expenditure** to education in many fiscal years (UNESCO, 2024).	Persistent underinvestment affects educational quality, institutional competitiveness, and progress toward the Sustainable Development Goals (SDGs).
Recurrent versus Capital Expenditure	**Recurrent expenditure continues to dominate institutional budgets.**	A substantial proportion of institutional budgets is devoted to salaries, pensions, and overheads, leaving limited funding for laboratories, ICT infrastructure, research facilities, and equipment procurement (TETFund, 2023).	Limited capital investment contributes to deteriorating infrastructure, obsolete laboratories, and weak research ecosystems.
Research Funding	**Gradual improvement**, driven largely by intervention funds and external grants.	Research funding is supported by TETFund, international donors, and competitive grants; however, national investment in research and development remains below the African Union target of **1% of GDP** (African Union, 2024).	Insufficient research funding constrains scientific productivity, postgraduate education, innovation, and technology commercialization.
Infrastructure Financing	**Investment increasing**, but below institutional needs.	Capital funding for classrooms, laboratories, workshops, hostels, and digital infrastructure has improved through intervention agencies but remains inadequate relative to demand (World Bank, 2024).	Infrastructure deficits continue to reduce teaching quality, research productivity, and student learning experiences.
Funding for STEM Programmes	**Growing policy attention**, but insufficient relative to cost.	STEM education requires significantly higher investment because of laboratory equipment, consumables, engineering workshops, computing facilities, and specialized teaching resources. Funding often falls short of these requirements (UNESCO, 2024).	Underfunding compromises practical training, research quality, innovation capacity, and graduate employability.
Digital Transformation Financing	**Increasing**, particularly following the COVID-19 pandemic.	Institutions have expanded investment in broadband, learning management systems, digital libraries, and ICT infrastructure. However, financing remains inadequate for comprehensive digital transformation (World Bank, 2024).	Limited digital investment slows adoption of AI, online learning, virtual laboratories, and smart campus technologies.

Internally Generated Revenue (IGR)	**Increasing gradually** as institutions diversify revenue sources.	Universities increasingly generate income through consultancy, continuing education, commercial ventures, endowments, and research services. However, IGR contributes only a modest share of total institutional financing in most public institutions (NUC, 2023).	Diversifying institutional revenue enhances financial resilience but cannot fully compensate for inadequate public funding.
Private Sector and Industry Investment	**Growing slowly**, with limited strategic partnerships.	Industry support for research, endowed chairs, scholarships, innovation centres, and collaborative research remains relatively limited compared with international best practice (OECD, 2019).	Weak private-sector investment limits technology commercialization, applied research, and workforce development.
Development Partner and Donor Funding	**Increasing**, particularly for research, digital education, and capacity building.	International organizations and development partners provide significant support for research, STEM education, digital transformation, quality assurance, and institutional strengthening[30].	Donor funding complements government investment but may not provide sustainable long-term financing.
Financial Sustainability	**Increasing concern** as operational costs continue to rise.	Rising inflation, exchange rate volatility, increasing enrolment, and higher energy costs have significantly increased institutional operating expenses without corresponding increases in funding[31].	Financial pressures threaten institutional quality, infrastructure maintenance, faculty retention, and long-term sustainability.
Funding Equity Across Institutions	**Persistent disparities** across institution types and regions.	Federal universities generally receive larger government allocations and intervention funding than many state universities and colleges, while institutional capacity to attract grants varies widely (NUC, 2023).	Unequal funding contributes to disparities in infrastructure, research productivity, educational quality, and graduate outcomes.

This analysis provides a strong evidence base for a national ICT-enabled STEM transformation strategy by linking higher education financing to infrastructure modernization, digital transformation, research excellence, innovation, and long-term institutional sustainability.

Table 2.13: Key trends in Funding Patterns and Budgetary Constraints

Area	Summary
Public Financing	Government remains the dominant source of funding, but allocations are insufficient relative to institutional needs.
Budget Composition	Recurrent expenditure absorbs most institutional budgets, limiting investment in infrastructure and research.
Research Investment	Research funding has improved through TETFund and international grants but remains below global benchmarks.
STEM Financing	High-cost STEM programmes remain underfunded relative to laboratory and equipment requirements.
Revenue Diversification	Institutions are expanding internally generated revenue, but dependence on government funding remains high.
Digital Investment	Investment in digital infrastructure is increasing but insufficient to support full digital transformation.
Financial Sustainability	Inflation, rising operational costs, and expanding enrolment continue to widen financing gaps.
Funding Equity	Significant disparities exist between federal, state, and private institutions and across geopolitical regions.

Strategic Policy Implications

In establishing a sustainable financing framework for higher education, the STEM transformation strategy seeks to prioritize:

1. **Increased public investment in higher education**, with a greater proportion allocated to capital development, research, and digital transformation, consistent with UNESCO financing recommendations (UNESCO, 2024).
2. **Adopt performance-based funding models** that reward teaching quality, research excellence, innovation, graduate employability, and institutional accountability.
3. **Strengthen TETFund interventions** by expanding support for research infrastructure, digital laboratories, postgraduate education, and emerging technologies.
4. **Diversify institutional revenue sources** through endowments, alumni giving, philanthropy, commercialization of research, executive education, consultancy, and intellectual property licensing.
5. **Promote stronger public–private partnerships (PPPs)** to finance STEM laboratories, innovation hubs, technology parks, and industry-focused research.
6. **Increase national investment in research and development (R&D)** toward the African Union benchmark of **1% of GDP** to strengthen innovation and competitiveness (African Union, 2024).
7. **Develop dedicated digital transformation funds** to support artificial intelligence, high-performance computing, smart classrooms, virtual laboratories, cybersecurity, and digital learning infrastructure.
8. **Improve financial management and accountability** through transparent budgeting, outcome-based expenditure tracking, digital financial systems, and regular performance audits.
9. **Establish an equitable funding formula** that considers institutional mission, student enrolment, STEM programme costs, regional disparities, and research performance to reduce inequalities across institutions.

2.7 Gender and Regional Disparities

Introduction

Equitable access to quality higher education is fundamental to achieving inclusive economic growth, social cohesion, and sustainable national development. Despite substantial expansion of Nigeria's higher education sector, significant disparities persist across gender, geographical regions, socioeconomic groups, and institution types. Women remain underrepresented in several STEM disciplines particularly engineering, computer science, physics, and technology, while students from underserved regions continue to face barriers related to infrastructure deficits, insecurity, poverty, inadequate digital connectivity, and limited institutional capacity. These inequalities affect enrolment, retention, graduation, research participation, academic leadership, and employment outcomes, ultimately constraining Nigeria's ability to fully utilize its human capital for innovation and industrial development. Analysis of gender and regional disparities is presented in Table 2.14 and 2.15. Reducing gender and regional disparities is therefore central to achieving the goals of the National Development Plan, the Sustainable Development Goals (SDGs), and the African Union's Continental Education Strategy for Africa.[30,31,32]

Table 2.14: Analysis of Gender and Regional Disparities

Indicator	Trend	Current Status	Implications
Gender Parity in Higher Education Enrolment	**Gradual improvement**, but disparities remain across regions and disciplines.	Female enrolment has increased steadily over the past decade; however, participation remains lower than that of males in several northern states and in many STEM programmes.[33,34]	Persistent gender disparities reduce women's participation in the knowledge economy and limit national human capital development.
Gender Disparity in STEM Disciplines	**Slow improvement**, with uneven progress across disciplines.	Women are better represented in medicine, biological sciences, pharmacy, and health sciences, but remain significantly underrepresented in engineering, computer science, physics, mathematics, and technology programmes.[35]	Low female participation limits diversity, innovation, leadership, and the availability of highly skilled STEM professionals.
Regional Access to Higher Education	**Persistent disparities** across geopolitical zones.	Southern Nigeria generally records higher tertiary enrolment rates and greater institutional density than many northern regions, where educational participation is affected by poverty, insecurity, cultural barriers, and limited educational infrastructure.[36]	Regional inequalities contribute to uneven human capital development, labour market outcomes, and economic opportunities.
Distribution of Higher Education Institutions	**Expansion nationwide**, but	Federal universities exist across all states; however, access to high-quality universities, specialized	Unequal institutional distribution limits educational opportunities

[30] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[31] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.
[32] African Union. (2016). Continental Education Strategy for Africa (CESA 16–25).
[33] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[34] National Board for Technical Education. (2023). Annual TVET and Polytechnic Statistics.
[35] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[36] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.

	unequal distribution remains.	STEM institutions, research centres, and advanced laboratories remains concentrated in selected regions.[37]	and research capacity in underserved regions.
Infrastructure Disparities	**Significant differences persist** among institutions and regions.	Universities in relatively better-funded regions generally possess stronger laboratories, ICT infrastructure, libraries, research facilities, and electricity supply than many institutions in underserved areas.[38]	Infrastructure disparities contribute to unequal learning experiences, research productivity, and graduate employability.
Digital Divide	**Improving gradually**, but regional inequalities remain substantial.	Reliable broadband connectivity, internet access, digital devices, and virtual learning facilities are more readily available in urban institutions than in many rural campuses.[39]	Digital inequalities restrict equitable access to online learning, AI-enabled education, digital research, and innovation opportunities.
Faculty Distribution	**Persistent imbalance** in academic staffing.	Highly qualified professors and researchers are concentrated in older federal universities and institutions located in major urban centres, while many state universities and rural institutions experience shortages of experienced faculty.[40]	Unequal faculty distribution affects teaching quality, postgraduate supervision, research productivity, and institutional competitiveness.
Research Capacity Across Regions	**Highly uneven**.	Research-intensive universities, Centres of Excellence, and internationally funded research programmes are concentrated in relatively few institutions, creating significant regional disparities in research output and innovation performance.[41]	Concentrated research capacity limits nationwide innovation and widens regional development gaps.
Gender Representation in Academic Staff and Leadership	**Gradual improvement**, but leadership gaps remain.	Women remain underrepresented among professors, vice-chancellors, rectors, provosts, deans, and senior researchers, particularly within STEM faculties.[42]	Limited female leadership reduces diversity in institutional governance, mentorship, and research leadership.
Socioeconomic Barriers	**Increasing concern** due to rising educational costs.	Students from low-income households face challenges related to tuition-related charges, accommodation, transportation, digital devices, and learning materials despite available scholarship programmes.[43]	Financial barriers reduce equitable access, increase dropout risks, and reinforce intergenerational inequality.
Students with Disabilities	**Growing policy attention**, but implementation remains limited.	Although inclusive education policies exist, many institutions still lack accessible classrooms, laboratories, digital learning	Limited accessibility reduces educational participation and employment opportunities for persons with disabilities.

[37] Federal Ministry of Education. (2022). Nigeria Education Sector Renewal Initiative (NESRI).
[38] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.
[39] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[40] National Universities Commission. (2023). Annual University System Report.
[41] Tertiary Education Trust Fund. (2023). Annual Report and Accounts.
[42] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[43] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.

		platforms, assistive technologies, and disability support services.[44]	
Graduate Employment Outcomes	**Regional disparities persist**.	Graduates from institutions located in major urban centres often benefit from stronger industry linkages, internship opportunities, entrepreneurship ecosystems, and employment networks than graduates from less-developed regions.[45]	Unequal employment opportunities reinforce regional economic disparities and reduce social mobility.

This analysis is directly applicable to an ICT-enabled STEM Transformation Strategy because it highlights the equity challenges that must be addressed to ensure inclusive access to high-quality STEM education, research, innovation, and digital opportunities across Nigeria.

Table 2.15: Key trends in Gender and Regional Disparities

Area	Summary
Gender Equity	Female participation is improving but remains uneven across STEM disciplines, academic leadership, and regions.
Regional Equity	Significant disparities persist in access, infrastructure, research capacity, and institutional quality across geopolitical zones.
Digital Inclusion	The urban–rural digital divide continues to affect equitable access to technology-enabled education.
Faculty Distribution	Experienced academic staff are concentrated in a relatively small number of institutions.
Research Capacity	National research performance is uneven due to regional disparities in infrastructure, funding, and institutional capacity.
Socioeconomic Inclusion	Poverty and rising education costs continue to limit access and student success for disadvantaged populations.
Disability Inclusion	Higher education institutions require greater investment in accessible infrastructure, assistive technologies, and inclusive learning environments.

Strategic Policy Implications

The STEM transformation strategy is to reduce gender and regional disparities in higher education with the following priorities:

1. **Expanding targeted scholarships and financial aid** for women, students from underserved regions, low-income households, and persons with disabilities, consistent with the objectives of the **National Policy on Education** and **SDG 4**.[46]
2. **Increasing investment in underserved institutions**, particularly in northern and rural regions, through equitable funding formulas that account for infrastructure deficits, institutional capacity, and regional development needs.[47]

[44] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[45] Organisation for Economic Co-operation and Development. (2019). Benchmarking Higher Education System Performance.
[46] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[47] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.

3. **Strengthening female participation in STEM** by providing scholarships, mentorship programmes, leadership development initiatives, and incentives for enrolment in engineering, computer science, mathematics, and technology disciplines.[48]
4. **Reducing the digital divide** through universal broadband connectivity, affordable internet access, digital devices, smart classrooms, and virtual laboratories across all higher education institutions.
5. **Promoting equitable distribution of qualified academic staff** through incentive schemes, research grants, housing support, and career development opportunities for faculty serving in underserved institutions.
6. **Strengthening regional research ecosystems** by establishing Centres of Excellence, shared research infrastructure, and innovation hubs in all geopolitical zones.
7. **Improving disability inclusion** by investing in accessible campuses, assistive technologies, inclusive curricula, and disability support services.
8. **Strengthening gender-responsive institutional policies** that promote equal opportunities in faculty recruitment, promotion, research leadership, governance, and decision-making.
9. **Enhancing university–community and university–industry partnerships** in disadvantaged regions to improve graduate employability, entrepreneurship, and local innovation ecosystems.

2.8 Global Benchmarking and Lessons for Nigeria

Introduction

Global benchmarking provides an important framework for evaluating the performance of higher education systems and identifying policies and practices that can strengthen national competitiveness. Countries that have successfully transformed their higher education sectors including South Korea, Singapore, Finland, China, and Malaysia have consistently invested in STEM education, digital infrastructure, research and development (R&D), faculty development, university–industry collaboration, innovation ecosystems, and strong governance frameworks.[49,50,51] While Nigeria has expanded access to higher education and increased scientific output, significant gaps remain in funding, infrastructure, digital transformation, research commercialization, and graduate employability (Table 2.16 and 2.17). Benchmarking against global best practices provides valuable lessons for developing an ICT-enabled STEM transformation strategy capable of positioning Nigeria as a regional leader in education, innovation, and industrial development.

Table 2.16: Analysis of Global Benchmarking and Lessons for Nigeria

Indicator	Global Trend/Best Practice	Status in Nigeria	Lessons and Implications for Nigeria
STEM Participation	Leading economies maintain high participation in STEM disciplines through early STEM exposure, scholarships, career	STEM enrolment is increasing but remains constrained by limited admission capacity, infrastructure deficits, and uneven participation	Expand STEM capacity, strengthen foundational sciences, and introduce incentives to improve participation, particularly among women and

[48] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[49] Organisation for Economic Co-operation and Development. (2019). Benchmarking Higher Education System Performance.
[50] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief.
[51] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support.

	guidance, and strong industry demand.[52]	across disciplines and gender.	underserved communities.
Investment in Research and Development (R&D)	Innovation-driven economies invest between **2–5% of GDP** in R&D, while the African Union recommends at least **1% of GDP**.[53]	Nigeria's R&D investment remains well below the African Union benchmark, with research funding heavily dependent on public intervention funds and international donors.	Increase public and private investment in R&D and establish sustainable competitive research funding mechanisms.
Digital Transformation	Leading universities integrate artificial intelligence, cloud computing, virtual laboratories, learning analytics, and smart campus technologies into teaching and research.	Digital transformation has accelerated but remains uneven due to inadequate ICT infrastructure, unreliable electricity, and limited digital skills.	Develop a national higher education digital transformation programme focused on broadband, AI, digital laboratories, cybersecurity, and faculty digital competencies.
University–Industry Collaboration	Strong partnerships support collaborative research, industrial PhDs, internships, technology transfer, and workforce development.	Collaboration is improving but remains fragmented and largely limited to consultancy, student placements, and isolated research partnerships.	Establish long-term strategic university–industry partnerships, co-funded research centres, and innovation clusters.
Research Commercialization	Leading universities operate technology transfer offices, science parks, incubators, and startup ecosystems that convert research into economic value.[54]	Commercialization of university research remains relatively limited, with low patenting rates and few university spin-off companies.	Strengthen intellectual property management, commercialization policies, incubators, and venture financing for university innovations.
Faculty Development	Continuous professional development includes digital pedagogy, leadership, industry attachment, and international mobility.	Faculty development programmes exist but remain inconsistent and often dependent on donor-funded initiatives.	Institutionalize mandatory CPD programmes focused on emerging technologies, digital teaching, research leadership, and innovation.
Funding Models	Successful systems utilize diversified financing through government funding, competitive grants, philanthropy, endowments, tuition, industry partnerships, and commercialization.	Public funding remains the dominant source of financing, while internally generated revenue, philanthropy, and private investment remain relatively limited.	Diversify higher education financing through performance-based funding, public–private partnerships, endowments, alumni engagement, and research commercialization.
Quality Assurance	Internationally competitive systems emphasize outcome-based education, accreditation, graduate employability, and continuous quality improvement.	Nigeria has established quality assurance systems, but implementation and monitoring remain uneven across institutions.	Strengthen accreditation, institutional benchmarking, graduate outcome tracking, and international quality standards.
Innovation Ecosystems	Leading innovation economies develop	Innovation hubs and incubation centres are	Establish regional innovation hubs, science

[52] OECD. (2019). Supporting Entrepreneurship and Innovation in Higher Education.
[53] African Union. (2024). Science, Technology and Innovation Strategy for Africa 2024–2034 (STISA-2034).
[54] World Intellectual Property Organization. (2024). Global Innovation Index 2024.

	integrated ecosystems linking universities, industry, government, investors, and entrepreneurs.	expanding but remain concentrated in a limited number of institutions.	parks, technology clusters, and startup accelerators across all geopolitical zones.
Internationalization	Global universities actively promote student mobility, joint degrees, international faculty recruitment, and collaborative research networks.	Nigerian institutions increasingly participate in international research collaborations but attract relatively few international students and faculty.	Expand international partnerships, faculty exchanges, dual-degree programmes, and participation in global research consortia.
Data-Driven Governance	Leading systems use integrated higher education management information systems (HEMIS), learning analytics, and performance dashboards to guide policy decisions.	Institutional data systems remain fragmented, limiting evidence-based planning, monitoring, and performance management.	Develop a National Higher Education Management Information System with real-time institutional data and performance indicators.
Graduate Employability	Top-performing systems integrate entrepreneurship, digital competencies, internships, and work-integrated learning into curricula.	Graduate unemployment and skills mismatches remain significant challenges despite increasing enrolment.	Modernize curricula to emphasize competency-based learning, entrepreneurship, AI, digital skills, and experiential education.

This analysis provides a global comparative perspective that directly inform Nigeria's ICT-enabled STEM Transformation Strategy by identifying proven policy approaches, institutional reforms, and investment priorities from high-performing higher education systems while adapting them to Nigeria's socioeconomic and development context.

Table 2.17: Key trends in Global Benchmarking and Lessons for Nigeria

Area	Global Benchmark	Nigeria's Position
STEM Participation	High participation supported by strong policy incentives	Growing participation but limited capacity and uneven distribution
R&D Investment	2–5% of GDP in leading economies	Below the African Union benchmark of 1% of GDP
Digital Transformation	Fully integrated digital learning ecosystems	Progressing but constrained by infrastructure and funding
Research Commercialization	Strong technology transfer and innovation ecosystems	Commercialization remains limited
Funding Models	Diversified and performance-based financing	Heavy dependence on government funding
Industry Collaboration	Strategic, institutionalized partnerships	Limited and project-based
Internationalization	Extensive global partnerships and mobility	Increasing but relatively modest
Governance	Data-driven institutional management	Fragmented institutional data systems

Strategic Policy Implications

Nigeria's higher education STEM transformation system with international best practice, policymakers to prioritize:

1. **Increase investment in higher education and R&D**, targeting at least **1% of GDP for research and development**, consistent with the African Union's Science, Technology and Innovation Strategy for Africa (STISA-2034).[55]
2. **Accelerate digital transformation** by investing in broadband infrastructure, smart classrooms, virtual laboratories, artificial intelligence, learning management systems, cloud computing, and cybersecurity.[56]
3. **Institutionalize university–industry collaboration** through industrial PhD programmes, collaborative research centres, technology parks, innovation districts, and co-funded research initiatives.
4. **Diversify higher education financing** by adopting performance-based funding models and expanding philanthropy, endowments, alumni giving, commercialization, and public–private partnerships.
5. **Strengthen faculty development** through continuous professional development, international mobility, industry attachments, digital pedagogy, leadership training, and research mentoring.
6. **Develop regional innovation ecosystems** that integrate universities, research institutes, industry, government agencies, investors, and entrepreneurs.
7. **Strengthen quality assurance systems** by implementing outcome-based education, graduate employability tracking, institutional benchmarking, and international accreditation standards.
8. **Establish an integrated National Higher Education Management Information System (HEMIS)** to support evidence-based policymaking, institutional performance monitoring, and strategic planning.
9. **Expand internationalization** by increasing participation in global research networks, joint degree programmes, faculty exchanges, and international student recruitment.
10. **Modernize curricula** to integrate entrepreneurship, artificial intelligence, digital competencies, sustainability, green chemistry, renewable energy, advanced manufacturing, and interdisciplinary problem-solving

[55] African Union. (2024). Science, Technology and Innovation Strategy for Africa 2024–2034 (STISA-2034).
[56] UNESCO. (2024). UNESCO Science Report; Global Education Monitoring Report.

CHAPTER THREE

ICT-ENABLED STEM POLICY DEVELOPMENT FRAMEWORK

3.1 National STEM Education Policy

Introduction

Nigeria does not currently have a single, stand-alone **National ICT-enabled STEM Education Policy** that governs all aspects of Science, Technology, Engineering and Mathematics (STEM) education. Instead, the country's STEM agenda is implemented through a **policy ecosystem** comprising the **National Policy on Education (NPE)**, the **National Policy on Science and Technology Education (NPSTE)**, the **National Science, Technology and Innovation Policy (NSTIP)**, the **Nigeria Education Sector Renewal Initiative (NESRI)**, and sector-specific policies implemented by the Federal Ministry of Education and the Federal Ministry of Innovation, Science and Technology. Together, these policies provide the legal, institutional, and strategic framework for strengthening STEM education from basic to tertiary education, promoting research and innovation, developing technical skills, and supporting Nigeria's transition to a knowledge-driven and technology-based economy (Table 3.1).

Table 3.1: Overview of Nigeria's Existing STEM Policy and Regulatory Frameworks

Policy	Purpose	Key STEM Provisions	Implications for Higher Education
National Policy on Education (NPE)	Provides the overall philosophy and direction for Nigeria's education system.	Promotes science, mathematics, technology, ICT, technical and vocational education across all education levels; emphasizes practical learning, innovation, entrepreneurship, and national development.[57]	Serves as the foundational policy guiding STEM curriculum development, quality assurance, teacher education, and institutional development.
National Policy on Science and Technology Education (NPSTE)	Establishes a national framework for science and technology education.	Promotes inquiry-based science education, practical laboratory learning, teacher capacity development, curriculum modernization, ICT integration, gender inclusion, and stronger science-industry linkages.[58]	Guides curriculum reform, laboratory development, STEM teacher preparation, and quality improvement in universities, polytechnics, and colleges of education.
National Science, Technology and Innovation Policy (NSTIP)	Strengthens science, technology, innovation, industrial development, and knowledge commercialization.	Supports STEM human capital development, emerging technologies, innovation ecosystems, entrepreneurship, commercialization of research, digital technologies, AI, biotechnology, renewable	Encourages universities to become innovation hubs supporting industrialization and economic diversification.

[57] https://policyvault.africa/policy/national-policy-on-education-4th-edition/?utm_source=chatgpt.com
[58] https://education.gov.ng/wp-content/uploads/2020/09/National-Policy-On-Science-and-Technology-Education.pdf?utm_source=chatgpt.com

		energy, and industry partnerships.[59]	
Nigeria Education Sector Renewal Initiative (NESRI)	Modernizes Nigeria's education system through digital transformation and quality improvement.	Prioritizes digital learning, STEM education, teacher development, ICT infrastructure, competency-based education, and improved learning outcomes.[60]	Accelerates ICT-enabled STEM teaching, learning, and institutional modernization.
Technical and Vocational Education and Training (TVET) Policy Framework	Expands technical and vocational skills aligned with labour market needs.	Strengthens engineering technology, applied sciences, digital skills, entrepreneurship, and industry collaboration.[61]	Supports production of technicians, technologists, and applied STEM professionals for industry.

Major Policy Objectives

Nigeria's existing STEM policy framework seeks to:

1. Develop scientifically and technologically literate citizens capable of contributing to national development (National Policy on Education).
2. Improve access to quality STEM education at all levels, particularly for girls and underserved populations (NPSTE; NPE).
3. Strengthening science, engineering, technology, and mathematics curricula through competency-based and practical learning approaches.
4. Promote research, innovation, entrepreneurship, and commercialization of research outcomes through stronger university–industry collaboration (NSTIP).
5. Developing human capital required for industrialization, digital transformation, food security, renewable energy, healthcare, and national competitiveness.
6. Strengthen teacher education and continuous professional development in STEM disciplines.
7. Expand digital literacy and ICT integration throughout the education system.
8. Promote gender equity and inclusive participation in STEM education.

The strategic pillars of the existing STEM policy framework and the policy focus are presented in Table 3.2.

Table 3.2: Strategic Pillars of Nigeria's STEM Policy Framework

Strategic Pillar	Policy Focus
STEM Curriculum Reform	Modernize curricula to include coding, robotics, AI, data science, biotechnology, climate science, entrepreneurship, and problem-based learning.
Teacher Capacity Development	Improve STEM teacher recruitment, certification, professional development, and digital pedagogy.
Laboratory and Infrastructure Development	Modernize laboratories, workshops, ICT infrastructure, and digital learning environments.
Research and Innovation	Strengthen university research, technology transfer, patents, innovation hubs, and commercialization.

[59] https://www.policyvault.africa/policy/national-policy-on-science-technology-and-innovation/?utm_source=chatgpt.com
[60] https://en.wikipedia.org/wiki/Federal_Ministry_of_Education_%28Nigeria%29?utm_source=chatgpt.com
[61] https://www.intechopen.com/chapters/88998?utm_source=chatgpt.com

Digital Transformation	Expand broadband, smart classrooms, virtual laboratories, AI-enabled learning, and cybersecurity education.
Industry Collaboration	Promote internships, industrial attachment, collaborative research, and workforce alignment.
Gender and Inclusion	Increase participation of women, rural communities, and disadvantaged groups in STEM education.
Governance and Quality Assurance	Strengthen accreditation, performance monitoring, institutional autonomy, and evidence-based policymaking.

Institutional Responsibilities

The successful implementation of Nigeria's STEM education framework depends on effective coordination among multiple government ministries, regulatory agencies, funding bodies, curriculum development institutions, and higher education institutions. Each institution has a distinct mandate that contributes to policy formulation, regulation, quality assurance, curriculum development, research funding, teacher education, and the promotion of science, technology, engineering, and mathematics across all levels of education as shown in Table 3.3. Collectively, these institutions are responsible for creating an enabling environment that supports high-quality STEM teaching, research, innovation, digital transformation, and workforce development. Strong collaboration among these agencies is essential to ensure policy coherence, efficient resource utilization, improved accountability, and alignment of STEM education with Nigeria's national development priorities, the Digital Economy Policy and Strategy, the National Development Plan (2021–2025), and the Sustainable Development Goals.[62,63]

Table 3.3: Institutional Responsibilities for implementation of Nigeria's STEM Policy Framework

Institution	Primary Responsibility for STEM Policy Framework
Federal Ministry of Education	Formulates education policy, curriculum oversight, teacher development, and education quality assurance.
Federal Ministry of Innovation, Science and Technology	Develops national science, technology, research, and innovation policies and coordinates national STI programmes.
National Universities Commission	Regulates university education, accreditation, minimum academic standards, and STEM programme quality.
National Board for Technical Education	Regulates polytechnics, technical colleges, and TVET institutions.
National Commission for Colleges of Education	Regulates teacher education and STEM teacher preparation programmes.
Tertiary Education Trust Fund	Finances research, laboratories, infrastructure, academic staff development, and innovation.
Nigerian Educational Research and Development Council	Developing curricula and instructional materials, including STEM curricula across education levels.

Key Challenges in Implementing existing STEM Policy in Nigeria

Nigeria has established a comprehensive policy framework to promote STEM education through the **National Policy on Education**, the **National Policy on Science and Technology**

[62] Federal Ministry of Education. (2022). National Policy on Science, Technology and Innovation. Federal Ministry of Education, Abuja, Nigeria.
[63] UNESCO. (2024). Global Education Monitoring Report and Nigeria Education Country Brief. & National Universities Commission. (2023). Annual University System Report.

Education, the **National Science, Technology and Innovation Policy**, and the **Nigeria Education Sector Renewal Initiative (NESRI)**. These policies collectively emphasize expanding access to STEM education, improving teaching quality, strengthening research and innovation, promoting digital transformation, and developing the skilled workforce needed for national development.[64] However, despite these well-articulated policy objectives, implementation has been uneven and has not fully translated into the desired improvements in STEM education outcomes. Several systemic challenges continue to limit effective implementation. These include:

1. Insufficient public investment in STEM education and research.
2. Inadequate laboratories, workshops, and digital infrastructure.
3. Shortages of qualified STEM teachers and academic staff.
4. Weak university–industry collaboration and limited commercialization of research.
5. Persistent gender and regional disparities in STEM participation.
6. Fragmented policy coordination among education, science, and innovation institutions.
7. Low investment in emerging technologies such as artificial intelligence, advanced manufacturing, biotechnology, and quantum technologies.
8. Weak monitoring and evaluation systems for measuring STEM education outcomes.
9. limited integration of digital technologies into teaching and learning,

In addition, fragmented governance arrangements, weak monitoring and evaluation systems, and the absence of a unified national STEM implementation framework have reduced policy coherence and slowed the translation of policy into measurable outcomes. Addressing these implementation bottlenecks will require stronger inter-agency collaboration, sustainable financing, evidence-based planning, improved accountability, and coordinated investments in infrastructure, human capital, research, and digital technologies to realize Nigeria's vision of a globally competitive, innovation-driven economy.[65]

In addressing the above challenges and to accelerate Nigeria's Higher education STEM transformation, an elaboration of a national ICT- enabled STEM Transformation strategy for higher education is developed. The strategy is prioritising

1. Designing and implementing a **dedicated National ICT-enabled STEM Education Strategy** that harmonizes existing education, science, innovation, and digital economy policies.
2. Increasing public expenditure on STEM infrastructure, laboratories, research, and digital technologies.
3. Modernization of STEM curricula to include AI, robotics, data science, climate technologies, renewable energy, and advanced manufacturing.
4. Strengthening teacher education and continuous professional development in STEM.
5. Expanding university–industry partnerships, innovation hubs, and technology transfer offices.
6. Improving participation of women and underserved communities through targeted scholarships and mentoring.
7. Establishing a national STEM education monitoring and evaluation framework with measurable key performance indicators.

[64] Federal Ministry of Education. (2022). Nigeria Education Sector Renewal Initiative (NESRI).
[65] World Bank. (2024). Higher Education for Development: An Evaluation of the World Bank Group's Support and World Intellectual Property Organization. (2024). Global Innovation Index 2024.

8. Strengthening collaboration between government, industry, academia, and international partners to build a globally competitive STEM ecosystem.
9. Reforming existing legislation to support STEM strategy implementation

Ultimately, the success of Nigeria's STEM agenda will depend not only on the quality of its policies but also on sustained political commitment, effective governance, strategic investment, and coordinated implementation. By translating policy into action, Nigeria can strengthen its higher education system, build a globally competitive STEM workforce, foster innovation, and accelerate progress toward the goals of the **National Development Plan (2021–2025)**, the **African Union Agenda 2063**, and the **United Nations Sustainable Development Goals**, particularly **SDG 4 (Quality Education)**, **SDG 5 (Gender Equality)**, **SDG 8 (Decent Work and Economic Growth)**, and **SDG 9 (Industry, Innovation and Infrastructure)**.[66]

3.2 Design of the National STEM Transformation Strategy

Introduction

A robust National strategy on higher education STEM transformation provides the strategic direction, legal backing, and operational guidelines necessary to drive sustainable STEM transformation across higher education. The main aim of the AFD funding is to support Nigeria in the design and implementation of a transformation strategy for STEM Higher Education in Nigeria. This follows a comprehensive report on upgrading STEM higher Education submitted to the National University Commission of Nigeria.[67] The report applied the analytical framework developed in *The Challenges of Establishing World-Class Universities*.[68] According to the report, The superior results of high-performing institutions (HPIs) highly sought graduates at the national and international levels, leading-edge research, and dynamic knowledge and technology transfer—can essentially be attributed to three complementary sets of factors at play in top universities: (a) a high concentration of talent (faculty and students), (b) abundant resources to offer a rich learning environment and conduct advanced research, and (c) favorable governance features that encourage strategic vision, innovation, and flexibility, enabling institutions to make decisions and manage resources without being encumbered by bureaucratic administrative constraints.

Theory of Change

In designing the National ICT-enabled STEM transformation strategy for higher education in Nigeria the strategic planning and evaluation framework is based on the Theory of Change (ToC). The theory explains how and why desired changes are expected to occur by mapping the causal pathways between interventions, outputs, outcomes, and long-term impacts. Unlike traditional logical frameworks that focus mainly on activities and outputs, a Theory of Change explicitly identifies the assumptions, contextual factors, risks, and evidence linking each stage of change. It provides policymakers with a roadmap for designing, implementing, monitoring, and evaluating complex reforms (Figure 1).[69]

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[66] African Union. (2024). Science, Technology and Innovation Strategy for Africa (STISA-2034); United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development.
[67] Salami, M. O. (2020). Brain drain and capacity development in Nigerian universities. African Journal of Public Affairs, 11(3), 55–72.
[68] Salami, J. (2009). The challenge of establishing world-class universities. World Bank.
[69] United Nation Environment Programme (UNEP) (2021). Theory of Change, https://www.unep.org/evaluation-office/our-evaluation-approach/theory-change

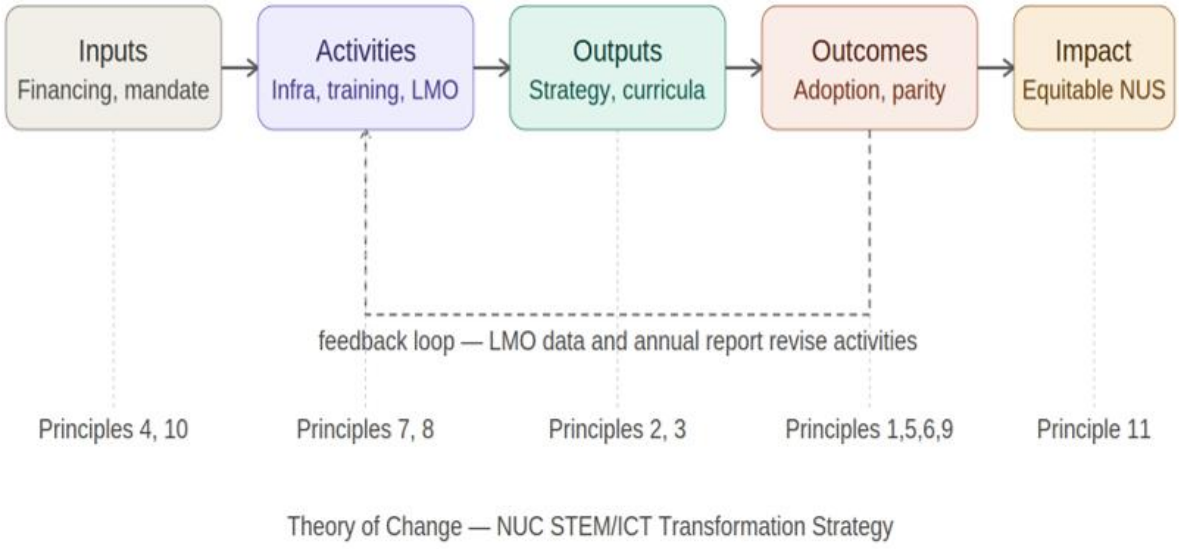

Figure 1: Theory of Change – NUCSTEM/ICT Transformation Strategy

The theory of change has the causal pathway from **inputs → activities → outputs → outcomes → impact**.

Inputs: Blueprint-ICT-Dev Project financing; the Committee's Terms of Reference; NUC regulatory authority over accreditation and minimum academic standards.

Activities: Infrastructure upgrades in beneficiary universities (Component One); development of the STEM Transformation Strategy and Labour Market Observatory (Component Two); faculty digital-pedagogy training; curriculum review against labour-market data; pilot selection and monitoring.

Outputs: Upgraded connectivity and digital infrastructure in beneficiary institutions; a published
STEM Transformation Strategy; an operational Labour Market Observatory; certified faculty cohorts; revised STEM/ICT curricula; documented pilot results with scale-up plans.

Outcomes: Increased female enrolment and completion in STEM disciplines; STEM/ICT curricula demonstrably aligned with current labour-market demand; faculty actively using ICT in teaching at UNESCO ICT-CFT "knowledge deepening" level or above; non-pilot institutions adopting practices proven in pilots; sustained institutional financing beyond the grant period.
Impact: A Nigerian University System that produces globally competitive, employable STEM/ICT graduates at scale, with reduced disparity between federal, state, and private institutions, and a measurable contribution to Nigeria's digital economy and to the African Union's Decade of Education and Skills Development targets (Figure 2).

For Nigeria's STEM transformation strategy, a Theory of Change is particularly valuable because improving STEM education requires coordinated reforms across governance, curriculum, teacher development, digital infrastructure, research funding, industry

partnerships, gender equity, and innovation ecosystems. Sustainable transformation can only occur if these interconnected components reinforce one another over time.[70]

Core Policy Principles

Nigeria's STEM transformation is guided by the principles of inclusivity, quality, innovation, collaboration, accountability, and sustainability, ensuring that investments in science and technology translate into equitable growth, national resilience, and global competitiveness. These principles guide the design, implementation, and evaluation of Nigeria's ICT-enabled STEM transformation strategy for Tertiary Education, ensuring that investments are inclusive, impactful, and globally competitive. These core principles include:

1. Equity, Inclusion, and Access

Ensure all Nigerians regardless of gender, geography, or socioeconomic status have access to quality STEM education and opportunities. This shall be achieved through:

i. Prioritizing girls, rural communities, and underserved regions and
ii. Bridging digital and infrastructure gaps.

2. Quality and Relevance

Aligning STEM education and research with national development priorities and industry needs. This shall be through:

i. Promoting competency-based learning and
ii. Regularly updating curricula to reflect emerging fields such as AI, biotech, clean energy etc

3. Innovation and Entrepreneurship

Encouraging a culture of creativity, problem-solving, and enterprise through:

i. Supporting startups, incubators, applied science and tech hubs and
ii. Incentivizing commercialization of research outputs

4. Research Excellence and Impact

Promoting high-quality, locally relevant, and globally competitive research by:

i. Focusing on applied research that solves real problems and
ii. Strengthening peer review, funding systems, and performance metrics

5. Private Sector Engagement, Collaboration and Partnerships

Fostering strong linkages across sectors and borders as well as positioning industry as a key driver of STEM development. These will be achieved through:

i. Encouraging government–academia–industry engagement and collaboration;
ii. Leveraging international partnerships and diaspora expertise;
iii. Incentivizing private investment in Research and innovation; and

[70] United Nations Educational, Scientific and Cultural Organization. (2021). Engineering for Sustainable Development: Delivering on the SDGs; World Bank. (2020). The Human Capital Index 2020 Update: Human Capital in the Time of COVID-19.

iv. Aligning training with labour market needs

6. Infrastructure, Digital-First, Future-Oriented and Open Access

Developing and optimizing shared STEM infrastructure as well as embedding digital transformation and emerging technologies across all STEM efforts. This shall be achieved through:

i. Investing in laboratories, digital platforms, and data systems;
ii. Promoting and funding initiatives like national research equipment databases;
iii. Expanding digital infrastructure and connectivity in all tertiary institutions;
iv. Promoting and funding AI, robotics, and additive manufacturing hubs;
v. Encouraging lifelong digital learning; and
vi. Encouraging open science and resource sharing

7. Evidence-Based Policy and Accountability

Base decisions on data and ensure transparency in implementation.

i. Using data systems to track progress and outcomes;
ii. Establishing clear monitoring, evaluation, and learning frameworks;
iii. Clear governance structures and roles;
iv. Transparent funding and procurement systems; and
v. Regular public reporting of outcomes

8. Sustainability and Resilience

Ensuring long-term viability of STEM investments.

i. Promoting environmentally sustainable technologies;
ii. Building systems that can adapt to future disruptions;
iii. Investing in green technologies and climate solutions;
iv. Building resilient research and innovation systems; and
v. Promoting sustainable funding mechanisms.

9. Global Competitiveness and Localization

Balance global standards with local relevance.

i. Benchmarking against international best practices;
ii. Adapting solutions to Nigeria's unique context;
iii. Addressing Nigeria-specific challenges (agriculture, energy, health);
iv. Aligning with international standards and frameworks (e.g., SDGs);
v. Promoting global research collaboration

10. Scalability and Impact Orientation

Designing programmes that can grow and deliver measurable results at scale.

i. Pilot → evaluate → scale successful interventions;
ii. Focusing on job creation, productivity, and innovation outputs; and
iii. Prioritize high-impact sectors like Solid minerals, Oil and Gas, Power, etc

The ICT-enabled STEM Transformation Strategy

The STEM transformation strategy has four principal dimensions namely:

1. Definition of vision and strategic goals
2. Education and training of STEM professionals
3. Research and technology transfer in STEM strategic areas
4. Strengthening of enabling factors

Definition of Vision:

According to Salami (2020)[71] the vision of a National STEM transformation strategy must be defined based on the priorities of the country's development strategy. The Nigerian Government has defined her priorities for the development of STEM capacities which aligns with the development strategy (**Figure 2**).

Vision Statement

To position Nigeria as a globally competitive, innovation-driven knowledge economy by advancing inclusive and sustainable ICT-enabled STEM education, fostering cutting-edge research, entrepreneurship, and industrial growth, and building a highly skilled workforce within a vibrant research and innovation ecosystem for national prosperity.

Mission Statement

To cultivate an inclusive, resilient, and globally competitive STEM ecosystem in Nigeria by strengthening capacity development, driving collaborative research, forging strategic partnerships, and investing in innovation systems that deliver solutions to local and global challenges.

Strategic Goals

The overall strategic goal is to develop a globally competitive, innovation-driven ICT-enabled STEM Higher Education system that supports Nigeria's sustainable economic growth and national development. This is further broken down into twelve specific goals as follows:

i. Increased access and equity in STEM Education by increasing enrolment, gender equity, and STEM pipeline development.
ii. Improved quality of STEM teaching and learning by modernizing curricula, integrating digital learning, and strengthening Quality Assurance systems.
iii. Strengthened research and innovation capacity by increasing research and innovation funding, research outputs, and commercialization.
iv. World-class STEM infrastructure developed by upgrading laboratories, building national equipment platforms, and improving digital infrastructure.
v. Enhanced human capital and faculty capacity by training faculty, improving recruitment, and engaging diaspora.
vi. Strengthened industry–academia linkages by expanding partnerships, internships, and joint research.
vii. Entrepreneurship and innovation ecosystem by establishing hubs, supporting startups, and integrating entrepreneurship.
viii. Digital transformation and emerging technologies by Integrating AI, IoT, digital skills, and open science platforms.
ix. Governance, policy, and financing by strengthening policy, increasing funding, and improving monitoring and evaluation.
x. Global competitiveness and collaboration by promoting partnerships, rankings, and mobility.
xi. alignment with national development priorities by focusing research on key sectors and problem-solving innovation.
xii. Sustainability and social impact by integrating sustainability and enhancing community engagement.

[71] Salami, M. O. (2020). Brain drain and capacity development in Nigerian universities. African Journal of Public Affairs, 11(3), 55–72.

Figure 2: Nigeria's Strategic Development Domains[72,73,74,75,76]

Economic Diversification and Industrialization	Human Capital Development
Reducing dependence on crude oil by expanding agriculture, manufacturing, mining, digital technology, and the creative economy.	Increase access to quality education, strengthen STEM education, improve healthcare delivery, reduce maternal and child mortality, and develop a workforce capable of supporting innovation-driven economic growth
Digital Economy and Innovation Expanding broadband infrastructure, strengthening digital literacy, supporting research and innovation, promoting artificial intelligence, improving e-government services, and developing the digital economy to create employment opportunities	**Job Creation and Youth Empowerment** Employment generation through entrepreneurship, vocational education, industrial development, innovation ecosystems, and support for MSMEs.
Food Security and Agricultural Transformation Increasing agricultural productivity, improving irrigation, strengthening agricultural value chains, promoting climate-smart agriculture, reducing post-harvest losses, and improving food security	**Energy Transition and Climate Resilience** Renewable energy deployment, clean cooking technologies, energy efficiency, climate adaptation, sustainable natural resource management, and implementation of the Energy Transition Plan to achieve net-zero emissions by 2060
Infrastructure Development Reliable electricity, transport networks, broadband connectivity, water supply, housing, and logistics systems that facilitate industrialization and regional integration	**Security and Social Stability** Strengthening national security institutions while addressing the socioeconomic drivers of conflict through inclusive development
Good Governance and Institutional Reform Strengthening public institutions, improving transparency, combating corruption, enhancing public financial management, judicial reforms, and improving service delivery remain central to Nigeria's development agenda	**Science, Technology, Research and Innovation** Strengthen research capacity, university-industry collaboration, ICT-enabled education, technology commercialization, and innovation ecosystems. Investment in STEM education and research infrastructure is expected to enhance national competitiveness and accelerate industrial development

Alignment with National Development Frameworks

The policy is anchored in existing national frameworks such as:

i. Nigeria's National Development Plan (NDP)
ii. National Policy on Education (NPE)
iii. Digital Economy Policy and Strategy (NDEPS)
iv. National Science, Technology and Innovation Policy (NSTIP)

This ensures coherence across sectors and avoids duplication of efforts.

Governance and Institutional Framework

[72] Federal Government of Nigeria. (2021). Medium-Term National Development Plan (2021–2025). Abuja: Federal Ministry of Budget and National Planning.
[73] Federal Government of Nigeria. (2023). Renewed Hope Agenda (2023–2027). Abuja.
[74] Federal Government of Nigeria. (2022). Nigeria Energy Transition Plan. Abuja: Presidential Steering Committee on Energy Transition.
[75] World Bank. (2024). Nigeria Development Update: Building Momentum for Inclusive Growth. Washington, DC: World Bank.
[76] Federal Ministry of Agriculture and Food Security. (2023). National Agricultural Technology and Innovation Policy. Abuja.

Effective implementation requires clearly defined roles across:

1. Federal Ministry of Education (FME): Policy formulation, oversight, and coordination.
2. National Universities Commission (NUC): Regulation, accreditation, and quality assurance of STEM programmes.
3. Tertiary Education Trust Fund (TETFund): Funding for infrastructure, research, and staff development.
4. Universities: Institutionalization of STEM reforms through curriculum redesign, pedagogy, and research.
5. A multi-stakeholder advisory council including industry, academia, and civil society is recommended.

Curriculum Standards and Reform Guidelines

The policy mandates:

1. Periodic curriculum review cycles (every 3–5 years).
2. Integration of Fourth Industrial Revolution (4IR) competencies.
3. Adoption of interdisciplinary and problem-based learning approaches.
4. Embedding digital literacy and computational thinking across all STEM disciplines.

Quality Assurance and Accreditation

To maintain standards, the policy has:

1. Establish national benchmarks for STEM programme delivery. To be implemented and monitored by the university CTL's.
2. Strengthened accreditation frameworks to include digital readiness and industry relevance.
3. Introduced performance indicators (graduate employability, research output, innovation impact).

Faculty Development and Capacity Building

The policy emphasizes:

1. Continuous Professional Development (CPD) requirements for STEM educators.
2. Certification in modern pedagogies (blended learning, flipped classrooms, etc.).
3. Incentives for research, innovation, and industry collaboration.

Infrastructure and Digital Ecosystem

Key provisions include:

1. Development of smart classrooms and virtual laboratories.
2. Expansion of broadband access and National Research and Education Networks (NRENs).
3. Establishment of innovation hubs, maker spaces, and incubation centres.

Equity, Inclusion, and Gender Mainstreaming

To address disparities the policy provides for:

1. Targeted scholarships and mentorship programmes for female STEM students.
2. Bridging programmes for disadvantaged or underprepared students.
3. Policies that promote inclusive learning environments.

Industry Linkages and Work-Based Learning

The strategy institutionalizes:

1. Mandatory internships, apprenticeship, SIWES, and cooperative education models.
2. Industry participation in curriculum design and delivery.
3. Joint research and innovation projects.

Funding and Resource Mobilization

The policy recommends multi-source sustainable funding model mechanisms which include:

1. **Government Allocations:**
   Federal and state education budgets.
2. **Private Sector:**
   Incentives for co-investment in labs, scholarships, and innovation hubs.
3. **International Development Partners:**
   Grants and technical assistance from UNESCO, World Bank, AfDB, and bilateral donors.
4. **National STEM Innovation Fund:**
   Dedicated fund for university-led startups and commercialization.
5. **Institutional budgets and endowments**

Monitoring, Evaluation, and Reporting

The STEM Transformation Strategy recommends a comprehensive Monitoring, Evaluation and Learning (MEL) framework aligned with Nigeria's National Monitoring and Evaluation Policy (2022) and the National Development Plan (2021–2025) to ensure evidence-based implementation, accountability, transparency and continuous improvement in STEM education and innovation outcomes.

Legal and Regulatory Instruments

The policy is backed by:

- Legislative frameworks to ensure compliance.
- Institutional guidelines and operational manuals.
- Enforcement mechanisms through regulatory bodies.

How the National STEM Strategy 2026 Applies to Higher Education

At the university level, this policy translates into:

- Development of institutional STEM strategies aligned with national goals.
- Establishment of STEM governance committees.
- Adoption of standardized curriculum frameworks.
- Integration of CPD and teaching innovation through Centres for Teaching and Learning (CTL's).

The policy provides a higher education STEM policy implementation **checklist document for universities to guide their implementation (see Appendix).**

3.3 Alignment with National Development Plans and Industrial Policy

3.3.1 Alignment with National Development Plans

The STEM Tertiary Education ICT-Driven Transformation Strategy aligns strongly with Nigeria's National Development Plans by positioning higher education as a catalyst for economic diversification, digital transformation, innovation, industrialization, and human capital development. In this area, the strategy further operationalizes several pillars of Nigeria's Federal Ministry of Finance, Budget and National Planning National Development Plan (NDP) 2021–2025 and the broader Nigeria Agenda 2050.

1. Human Capital Development

The strategy supports the NDP objective of building a "vibrant, educated and healthy populace" by strengthening STEM education, digital literacy, research capacity, and workforce readiness within tertiary institutions. It promotes the development of graduates equipped with 21st-century competencies required for the knowledge economy.

2. Digital Economy and ICT Expansion

The strategy aligns with Nigeria's digital economy agenda by integrating ICT, artificial intelligence, data science, cyber security, robotics, and emerging technologies into tertiary education systems. This directly supports the NDP's emphasis on broadband expansion, digital infrastructure, innovation ecosystems, and technology-enabled productivity growth.

3. Science, Technology and Innovation (STI)

The strategy advances the NDP goal of establishing a science-based and innovation-driven economy through:

i. strengthened STEM curricula,
ii. increased research and development (R&D),
iii. university-industry collaboration,
iv. technology transfer and commercialization,
v. innovation hubs and incubation centres.

These priorities are explicitly recognized within the NDP science, technology and innovation framework.

4. Industrialization and Economic Diversification

By producing highly skilled STEM graduates and supporting applied research, the strategy contributes to Nigeria's industrial policy objectives, particularly in manufacturing, digital services, engineering, renewable energy, and emerging technology sectors. It supports the transition from a resource-dependent economy to a knowledge-driven and innovation-led economy.

5. Employment Generation and Entrepreneurship

The strategy aligns with national priorities on youth employment and job creation by promoting:

i. digital entrepreneurship,
ii. innovation ecosystems,
iii. start-up incubation,
iv. industry-relevant technical skills,
v. employability-focused STEM training.

This complements government efforts to expand Nigeria's technology and innovation ecosystem.

6. Research, Innovation and Global Competitiveness

The strategy supports the NDP's vision of enhancing Nigeria's global competitiveness through investment in research infrastructure, smart technologies, innovation centres, and collaborative knowledge production between academia, industry, and government (Triple Helix model).

7. National Digital Transformation and Smart Governance

The integration of ICT-enabled teaching, e-learning systems, digital administration, and data-driven institutional governance aligns with Nigeria's broader digital transformation agenda and e-government initiatives.

3.3.2 Alignment with Nigeria's Industrial Policy Priorities

The STEM Tertiary Education ICT-Driven Transformation Strategy aligns with Nigeria's Industrial Policy by developing the skilled workforce, innovation capacity, digital infrastructure, and research ecosystem required to drive industrialization, economic diversification, and global competitiveness. The strategy directly supports the objectives of the Federal Ministry of Industry, Trade and Investment Industrial Revolution Plan, Nigeria Agenda 2050, and the National Development Plan (2021–2025).

1. Human Capital for Industrial Growth

The strategy supports industrial policy goals by producing industry-ready STEM graduates with competencies in:

i. engineering and advanced manufacturing,
ii. ICT and digital technologies,
iii. artificial intelligence and robotics,
iv. renewable energy technologies,
v. data science and automation,
vi. technical and vocational innovation.

This strengthens Nigeria's industrial workforce and reduces dependence on foreign technical expertise.

2. Technology-Driven Industrialization

The strategy aligns with Nigeria's industrial modernization agenda by integrating:

i. digital technologies,
ii. smart manufacturing systems,
iii. Industry 4.0 competencies,
iv. automation and innovation,
v. applied scientific research,

into tertiary education and research systems.

This supports the transition toward knowledge-based and technology-enabled industries.

3. Research, Innovation and Commercialization

The strategy advances industrial policy objectives through:

i. university-industry collaboration,
ii. innovation hubs and technology parks,
iii. commercialization of research outputs,
iv. incubation of start-ups and SMEs,
v. applied research addressing national industrial challenges.

This strengthens the national innovation ecosystem and promotes indigenous technology development.

4. Economic Diversification

The strategy contributes to Nigeria's economic diversification agenda by supporting high-growth sectors such as:

i. ICT and digital economy,
ii. manufacturing,
iii. agriculture technology,
iv. renewable energy,
v. biotechnology,
vi. creative and innovation industries.

It reduces overreliance on oil by building capacity in productive and export-oriented sectors.

5. Entrepreneurship and SME Development

The strategy promotes industrial entrepreneurship through:

i. innovation and start-up ecosystems,
ii. digital entrepreneurship programmes,
iii. STEM enterprise development,
iv. technology incubation and mentorship.

This aligns with industrial policy priorities focused on SME growth, job creation, and youth empowerment.

6. Strengthening National Competitiveness

The strategy supports Nigeria's aspiration to become a competitive industrial economy by:

i. improving research quality,

ii. enhancing digital skills,
iii. fostering innovation culture
iv. strengthening tertiary-industry linkages,
v. promoting global standards in STEM education and workforce development.

7. Regional and Global Industrial Integration

The strategy prepares graduates and institutions for participation in:

i. the African Continental Free Trade Area (AfCFTA
ii. global technology markets,
iii. regional manufacturing value chains,
iv. digital trade and innovation ecosystems.

This enhances Nigeria's competitiveness within Africa and globally.

3.4 Alignment of the STEM Transformation Strategy with SDGs 4, 5 and 9

The National STEM Transformation Strategy aligns strongly with SDG 4 (Quality Education), SDG 5 (Gender Equality) and SDG 9 (Industry, Innovation and Infrastructure) by promoting inclusive and high-quality STEM education, advancing gender equity in science and technology fields, and strengthening innovation-driven industrial development for sustainable national transformation.

3.4.1 Alignment with SDG 4 – Quality Education

United Nations SDG 4 seeks to ensure inclusive, equitable and quality education and promote lifelong learning opportunities for all. The STEM Transformation Strategy aligns with this goal through the following policy directions:

1. Expanding access to quality STEM education across universities, polytechnics and colleges of education.
2. Modernising STEM curricula to reflect emerging technologies, digital competencies, innovation and industry needs.
3. Strengthening teacher capacity, digital pedagogy and research competence in STEM disciplines.
4. Promoting competency-based, experiential and problem-solving learning approaches.
5. Enhancing digital infrastructure, laboratories, innovation hubs and e-learning systems in tertiary institutions.
6. Supporting lifelong learning, reskilling and upskilling for the digital economy and future workforce.
7. Improving quality assurance, accreditation standards and outcome-based education in STEM programmes.

This alignment supports the development of globally competitive graduates equipped with 21st-century skills.

3.4.2 Alignment with SDG 5 – Gender Equality

United Nations SDG 5 aims to achieve gender equality and empower all women and girls. The STEM Transformation Strategy advances this goal by:

1. Promoting increased participation of women and girls in STEM education, research and innovation.

2. Establishing gender-responsive STEM policies, scholarships and mentorship programmes.
3. Reducing barriers that limit female participation in science, technology and engineering fields.
4. Encouraging inclusive learning environments free from discrimination and gender bias.
5. Supporting women-led innovation, entrepreneurship and leadership in STEM sectors.
6. Integrating gender equity indicators into STEM planning, monitoring and evaluation frameworks.

The strategy therefore contributes to narrowing gender gaps in STEM careers and strengthening women's participation in national development and the knowledge economy.

3.4.3 Alignment with SDG 9 – Industry, Innovation and Infrastructure

United Nations SDG 9 promotes resilient infrastructure, inclusive industrialisation and innovation. The STEM Transformation Strategy aligns with this goal through:

1. Strengthening research, innovation and technology development within tertiary institutions.
2. Promoting university-industry collaboration and public-private partnerships for applied research and commercialization.
3. Developing innovation ecosystems, technology parks, fabrication laboratories and incubation centres.
4. Building digital and physical infrastructure that supports advanced STEM teaching, research and entrepreneurship.
5. Producing a highly skilled workforce capable of driving industrial transformation and technological advancement.
6. Encouraging indigenous technology development, manufacturing and local content innovation.
7. Supporting entrepreneurship education and start-up development in STEM-related sectors.

This alignment positions STEM education as a catalyst for industrial growth, economic diversification and national competitiveness.

CHAPTER FOUR

EDUCATION AND TRAINING OF STEM PROFESSIONALS

4.1 Curriculum Modernization and Academic Reform

Introduction

Curriculum Modernization and Academic Reform is a cornerstone of the ICT-enabled STEM Transformation Strategy for Higher Education in Nigeria. The rapid evolution of digital technologies, automation, artificial intelligence, and data-driven innovation is fundamentally reshaping the skills required for the 21st-century workforce. Consequently, Nigerian higher education institutions must transition from predominantly content-based and examination-oriented curricula to competency-based, interdisciplinary, digitally enabled, and industry-responsive academic programmes that equip graduates with the knowledge, skills, attitudes, and entrepreneurial capabilities needed to thrive in an increasingly technology-driven global economy.

Despite significant expansion in tertiary education, many STEM curricula in Nigerian universities, polytechnics, and colleges of education remain outdated, fragmented, and insufficiently aligned with emerging technologies, national development priorities, and labour market demands. Limited integration of digital learning technologies, inadequate emphasis on experiential learning, weak industry participation in curriculum development, and slow curriculum review processes have contributed to persistent graduate skills mismatches and reduced employability.[77],[78]

The ICT-enabled STEM Transformation Strategy therefore proposes a comprehensive reform of curriculum design, delivery, assessment, and quality assurance across Nigeria's higher education system. The strategy promotes the adoption of competency-based education (CBE), outcome-based education (OBE), problem-based learning (PBL), project-based learning, blended and online learning models, virtual laboratories, simulation technologies, digital micro-credentials, interdisciplinary STEM programmes, and flexible learning pathways. These reforms will ensure that graduates acquire not only strong disciplinary knowledge but also digital literacy, computational thinking, critical thinking, innovation, entrepreneurship, communication, teamwork, ethical reasoning, sustainability awareness, and lifelong learning competencies.

ICT serves as the principal enabler of curriculum transformation by providing digital learning management systems, virtual classrooms, artificial intelligence-assisted learning platforms, adaptive learning technologies, cloud-based laboratories, open educational resources (OER), learning analytics, and digital assessment tools. These technologies enhance teaching effectiveness, improve student engagement, expand access to quality STEM education, support personalized learning, and strengthen institutional resilience during disruptions. Furthermore,

[77] United Nations Educational, Scientific and Cultural Organization. (2021). Engineering for Sustainable Development: Delivering on the SDGs.
[78] World Bank. (2020). The Human Capital Index 2020 Update: Human Capital in the Time of COVID-19.

digital technologies facilitate continuous curriculum improvement through data-driven decision-making, employer feedback, and real-time monitoring of student learning outcomes.

Academic reform also requires stronger collaboration between higher education institutions, industry, professional bodies, research institutions, regulatory agencies, and international partners. Regular curriculum reviews informed by labour market intelligence, emerging technologies, national innovation priorities, and global best practices will ensure that academic programmes remain relevant and internationally competitive. Greater emphasis will also be placed on work-integrated learning, industrial attachments, entrepreneurship education, innovation projects, capstone experiences, and undergraduate research to bridge the gap between classroom instruction and workplace practice.

This component aligns with Nigeria's aspirations for economic diversification, digital transformation, industrialization, and sustainable development by producing a highly skilled STEM workforce capable of driving research, innovation, technology commercialization, and national competitiveness. It supports national policy frameworks, including the Nigeria Education Sector Renewal Initiative (NESRI), the National Digital Economy Policy and Strategy, the National Policy on Science, Technology and Innovation, and the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 9 (Industry, Innovation and Infrastructure).[79] Through systematic curriculum modernization and academic reform, Nigeria's higher education institutions will become more agile, inclusive, globally connected, and responsive to the evolving demands of the digital economy.

Vision

To strengthen the digital, pedagogical and research competence of STEM academia in Nigerian universities in line with Nigeria's developmental priorities and global standards to that significantly improve students' retention in the STEM programmes; develop work force relevant skills and improve learning outcomes and research capability and output in STEM courses and.

Mission

To build the capacity of STEM professionals in the use of EduTech tools and their ability to integrate effective pedagogical practices in the use of these digital tools, such that students remain in the STEM programmes and develop workforce-relevant skills, improved learning outcomes and research output in STEM programmes.

Strategic Goals

The strategic goals (Table 4.1) of the Curriculum Modernization and Academic Reform component in this pillar are designed to transform STEM education in Nigerian higher education institutions into a dynamic, digitally enabled, learner-centred, industry-responsive, and globally competitive system. These goals focus on ensuring that curricula remain relevant to emerging technologies, national development priorities, and the evolving needs of the labour market while strengthening graduate employability, innovation, and research capacity.

[79] Federal Government of Nigeria (FGN). (2020). National digital economy policy and strategy (2020–2030); Federal Ministry of Education (FME). (2022). National Policy on Science and Technology Education. Government of Nigeria.

Table 4.1: Strategic Goals and Desired Outcomes for the Curriculum Modernization and Academic Reform

Strategic Goal	Desired Outcomes
1. Modernize STEM curricula to reflect emerging technologies and future workforce needs.	All STEM programmes aligned with national development priorities and global standards. Curricula updated to include Artificial Intelligence, Data Science, Robotics, Internet of Things (IoT), Cybersecurity, Renewable Energy, Biotechnology, Advanced Manufacturing, and Climate Technologies. Graduates possess competencies relevant to the Fourth Industrial Revolution (4IR) and Fifth Industrial Revolution (5IR).
2. Institutionalize competency-based and outcome-based education across higher education institutions.	Learning outcomes clearly defined for all STEM programmes. Teaching and assessment focus on practical competencies and problem-solving rather than rote learning. Improved graduate employability and professional readiness.
3. Strengthen ICT-enabled teaching, learning, and assessment.	Widespread adoption of Learning Management Systems (LMS), virtual laboratories, digital assessment platforms, simulation software, and AI-assisted learning tools. Increased access to flexible, blended, and online STEM education. Improved quality and effectiveness of teaching and learning.
4. Promote interdisciplinary and transdisciplinary STEM education.	Introduction of multidisciplinary degree programmes and collaborative learning models. Students develop systems thinking and cross-sector problem-solving capabilities. Greater integration of engineering, computing, environmental science, entrepreneurship, health, and social sciences.
5. Embed innovation, entrepreneurship, and commercialization into STEM curricula.	Entrepreneurship and ICT integrated into all STEM programmes. Increased student innovation projects, prototypes, patents, and technology start-ups. Stronger culture of innovation and enterprise among graduates.
6. Strengthen industry-academia collaboration in curriculum development and delivery.	Employers actively participate in curriculum review. Expansion of internships, industrial attachments, apprenticeships, and work-integrated learning. Graduates possess practical workplace competencies aligned with industry needs.
7. Enhance quality assurance and continuous curriculum improvement.	Regular curriculum review cycles based on labour market intelligence and technological trends. Improved accreditation outcomes. Adoption of international quality assurance standards and benchmarking practices.
8. Develop digital competencies among academic staff.	Faculty proficient in digital pedagogy, instructional technology, AI-enabled teaching, and online course development. Increased use of innovative teaching methodologies. Higher student engagement and improved learning outcomes.
9. Promote inclusive, equitable, and accessible STEM education.	Curricula accommodate diverse learning needs, including students with disabilities. Increased participation of women and underrepresented groups in STEM programmes. Reduced regional and socio-economic disparities in access to quality STEM education.
10. Strengthen lifelong learning and flexible education pathways.	Introduction of micro-credentials, stackable certificates, professional certifications, and flexible learning pathways. Increased opportunities for upskilling and reskilling throughout graduates' careers. Higher responsiveness of higher education to changing workforce demands.
11. Integrate sustainability and ethical leadership into STEM education.	Students develop competencies in sustainable development, climate resilience, environmental stewardship, ethics, and responsible innovation. STEM graduates contribute to national and global sustainability goals.
12. Position Nigerian STEM education for regional and global competitiveness.	Improved international recognition of Nigerian STEM qualifications.• Increased student and faculty mobility, international partnerships, and joint degree programmes. Nigerian universities become competitive hubs for STEM education, research, and innovation in Africa.

Strategic Interventions

The successful implementation of the Curriculum Modernization and Academic Reform component requires coordinated interventions at national, institutional, and departmental levels. The activities and programmes in Table 4.2 are designed to modernize STEM curricula, strengthen digital pedagogy, enhance industry relevance, improve graduate competencies, and establish continuous quality improvement mechanisms. Each programme is accompanied by measurable KPIs that will enable effective monitoring and evaluation.

Table 4.2: Activities, Programmes and Key Performance Indicators (KPIs) for Curriculum Modernization and Academic Reform

Strategic Goal	Strategic Interventions	Programmes/Projects	Key Performance Indicators (KPIs)
Modernize STEM curricula	Conduct comprehensive review of all STEM curricula every 3–5 years	National STEM Curriculum Review Programme	% of STEM programmes reviewed and updated. Number of revised curricula approved. Review cycle compliance rate
	Align curricula with global standards and labour market needs	Future-Ready STEM Curriculum Initiative	% of programmes aligned with international standards. Employer satisfaction index. Graduate competency index
Integrate emerging technologies	Introduce AI, Data Science, Robotics, IoT, Cybersecurity, Cloud Computing, Renewable Energy and Biotechnology modules	Emerging Technologies Curriculum Integration Programme	Number of programmes incorporating emerging technologies. Number of new digital courses developed. Student enrolment in emerging technology courses
Adopt competency-based education	Transition to Competency-Based Education (CBE) and Outcome-Based Education (OBE)	National Competency-Based Learning Initiative	% of programmes using CBE/OBE. Programme Learning Outcomes (PLOs) achieved. Student competency assessment scores
Promote digital learning	Deploy Learning Management Systems (LMS), virtual classrooms and digital content	Digital Learning Transformation Programme;	% of courses delivered through LMS. Number of institutions using blended learning. Student engagement rate on LMS
Strengthen virtual laboratories	Develop virtual laboratories and simulation-based practical learning	National Virtual STEM Laboratory Programme; centres of teaching and learning in HE institutions	Number of virtual laboratories established. Number of practical courses using simulations Student laboratory utilization rate
Modernize teaching methods	Promote project-based, problem-based, inquiry-based and experiential learning	Innovative Pedagogy Programme	% of courses adopting active learning methods Student satisfaction with teaching. Graduate problem-solving competency scores

Strengthen industry collaboration	Engage employers in curriculum design and delivery	Industry Curriculum Advisory Programme	Number of industry partners. Number of programmes with industry participation. Employer participation in curriculum reviews
Expand work-integrated learning	Increase internships, SIWES, apprenticeships, industrial attachments and capstone projects	National Work-Integrated Learning Programme	% of students completing internships. Number of industry placements. Graduate employability rate
Promote entrepreneurship	Embed entrepreneurship, innovation and commercialization into all STEM programmes	STEM Innovation and Entrepreneurship Programme	Number of entrepreneurship courses offered. Student startups created. Innovation competitions organized. Patents filed by students
Faculty capacity development	Train academic staff on digital pedagogy, AI-assisted teaching and curriculum design	DigitalFaculty Development Programme; faculty –wide WIFI and modern computing facilities.	• Number of lecturers trained • Faculty digital competency score • % of faculty certified in digital teaching
Digital assessment reform	Introduce e-assessment, e-portfolios and AI-enabled assessment systems	Smart Assessment Programme	% of assessments conducted digitally Student completion rates. Assessment turnaround time
Develop Open Educational Resources	Produce locally relevant digital teaching resources	National OER Development Initiative	Number of OER resources developed. Number of institutions using OER Student access rate
Promote interdisciplinary education	Develop multidisciplinary STEM programmes	Interdisciplinary STEM Education Programme	Number of interdisciplinary programmes launched. Student enrolment in interdisciplinary courses. Collaborative teaching initiatives
Strengthen quality assurance	Develop digital curriculum monitoring and quality assurance systems	Curriculum Quality Enhancement Programme	Accreditation success rate. Number of quality audits completed. Compliance with quality standards
Institutionalize curriculum analytics	Use learning analytics and labour market intelligence to improve curricula	Curriculum Intelligence and Analytics Platform	Graduate employment tracking system established. Labour market reports produced Curriculum revisions informed by analytics
Promote inclusive education	Develop inclusive curricula for women, persons with disabilities and underserved communities	Inclusive STEM Curriculum Programme	Female STEM enrolment Number of accessible digital learning resources. Disability inclusion compliance rate
Introduce micro-credentials	Develop stackable certificates and digital badges	National Micro-Credential Programme	Number of micro-credential courses offered Learners earning digital badges. Industry recognition of credentials

International benchmarking	Benchmark curricula against global universities and accreditation bodies	Global Curriculum Benchmarking Initiative	Number of benchmark studies completed. International accreditation achieved. Joint curriculum development initiatives
Strengthen graduate skills	Integrate soft skills, leadership, ethics and communication into curricula	Graduate Employability Skills Programme, Digital literacy training, computational skills	Graduate employability index. Employer satisfaction. Student soft skills assessment scores
Promote sustainability education	Mainstream sustainability, climate change and green technologies into STEM programmes	Green STEM Curriculum Initiative	Number of sustainability-related courses. Student participation in sustainability projects. Green innovation projects completed

Responsibilities

The implementation responsibility matrix (Table 4.3) provides a structured framework for assigning leadership and accountability for each strategic activity while identifying supporting institutions and the appropriate level of implementation—national, state, or institutional. National-level institutions, including the Federal Ministry of Education and regulatory agencies, are responsible for policy development, standards setting, quality assurance, resource mobilization, and system-wide coordination. State governments facilitate implementation within state-owned institutions, while universities, polytechnics, and colleges of education lead curriculum development, programme delivery, faculty development, and continuous quality improvement at the institutional level. Industry, professional bodies, and development partners provide technical expertise, workplace learning opportunities, research collaboration, and financial and technical support.

Table 4.3: Implementation Responsibility Matrix for Curriculum Modernization and Academic Reform

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level (National, State, Institutional)
Develop and periodically review national STEM curriculum frameworks	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, Professional Bodies	National
Review and modernize institutional STEM curricula	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education	Universities, Polytechnics, Colleges of Education, Industry Partners	National, Institutional
Integrate emerging technologies (AI, Data Science, IoT, Robotics, Cybersecurity, Cloud Computing) into curricula	Higher Education Institutions	Regulatory Agencies, Industry Partners, ICT Companies, Professional Bodies	Institutional

Adopt Competency-Based Education (CBE) and Outcome-Based Education (OBE)	National Universities Commission, National Board for Technical Education	Higher Education Institutions, Professional Accreditation Bodies	National, Institutional
Develop national guidelines for digital and blended learning	Federal Ministry of Education	Regulatory Agencies, ICT Agencies, Higher Education Institutions	National
Deploy Learning Management Systems (LMS) and digital learning platforms	Higher Education Institutions	State Ministries of Education, ICT Providers, Tertiary Education ICT Units	State, Institutional
Establish virtual laboratories and simulation-based learning facilities	Higher Education Institutions	Tertiary Education Trust Fund, Industry Partners, Development Partners	National, Institutional
Develop digital teaching and learning resources	Higher Education Institutions	Academic Staff, Professional Associations, Educational Technology Providers	Institutional
Train academic staff in digital pedagogy and innovative teaching methods	Tertiary Education Trust Fund	Regulatory Agencies, Universities, Teacher Training Institutes, International Partners	National, Institutional
Institutionalize project-based, problem-based and experiential learning	Higher Education Institutions	Industry Partners, Employers, Professional Bodies	Institutional
Strengthen industry participation in curriculum development	Federal Ministry of Education	Chambers of Commerce, Manufacturers' Associations, Professional Bodies, Employers	National, Institutional
Expand industrial attachments, internships and work-integrated learning	Higher Education Institutions	Employers, Private Sector, Government Agencies	Institutional
Integrate entrepreneurship and innovation into STEM programmes	Higher Education Institutions	Tertiary Education Trust Fund, Innovation Hubs, Incubators, Private Sector	Institutional
Establish interdisciplinary STEM degree programmes	Higher Education Institutions	Regulatory Agencies, Industry Experts, Research Institutes	Institutional
Develop micro-credentials, stackable certificates and lifelong learning programmes	National Universities Commission, National Board for Technical Education	Higher Education Institutions, Professional Certification Bodies	National, Institutional
Introduce digital assessment, e-portfolios and AI-enabled evaluation systems	Higher Education Institutions	ICT Providers, Regulatory Agencies	Institutional
Develop a National Open Educational Resources (OER) Platform	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, Higher Education Institutions	National
Promote inclusive and gender-responsive curriculum reforms	Federal Ministry of Education	State Ministries of Education, Higher Education Institutions, Development Partners, Civil Society Organizations	National, State, Institutional

Integrate sustainability, climate change and green technologies into STEM curricula	Higher Education Institutions	Environmental Agencies, Research Institutes, Industry Partners	Institutional
Establish curriculum quality assurance and continuous improvement systems	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education	Quality Assurance Units, Professional Accreditation Bodies	National, Institutional
Develop graduate tracer studies and labour market intelligence systems	Federal Ministry of Education	National Bureau of Statistics, Employers, Higher Education Institutions	National, Institutional
Benchmark Nigerian STEM curricula against international standards	National Universities Commission	International Universities, Accreditation Bodies, Development Partners	National
Monitor and evaluate implementation of curriculum modernization reforms	Federal Ministry of Education	Regulatory Agencies, State Ministries of Education, Higher Education Institutions, Independent Evaluators	National, State, Institutional

Key Performance Indicators

A robust Monitoring, Evaluation, Accountability and Learning (MEAL) framework is essential for tracking progress in implementing the **Curriculum Modernization and Academic Reform** component of Nigeria's ICT-enabled STEM Transformation Strategy. The Key Performance Indicators (KPIs) presented in Table 4.4 measure progress from the current baseline through short-term (Years 1–3), medium-term (Years 4–7), and long-term (Years 8–10) implementation periods. The indicators focus on curriculum relevance, digital transformation, teaching quality, graduate employability, industry engagement, inclusion, and institutional performance (Table 4.4). Baseline values represent estimated national averages that should be validated through a comprehensive national baseline assessment during the first year of implementation Short to long term KPIs will involve a logical progression from capacity building (short term) → institutionalization and improved outcomes (medium term) → system-wide transformation and global competitiveness (long term)**.**

Table 4.4: Key Performance Indicators (KPIs) for Curriculum Modernization and Academic Reform

KPI	Baseline (2026)	Short-Term Target (2027–2029)	Medium-Term Target (2030–2033)	Long-Term Target (2034–2036)
STEM programmes reviewed and modernized	15%	50%	80%	100%
STEM programmes aligned with Competency-Based and Outcome-Based Education (CBE/OBE)	20%	50%	80%	100%
Programmes integrating AI, Data Science, Robotics, IoT and Cybersecurity	15%	40%	70%	95%
Institutions implementing blended and digital learning	35%	65%	90%	100%

Courses available through Learning Management Systems (LMS)	40%	70%	90%	100%
Institutions with functional virtual laboratories	15%	40%	70%	90%
Academic staff trained in digital pedagogy	25%	60%	85%	100%
Academic staff certified in digital teaching competencies	10%	40%	70%	90%
Courses using project-based and problem-based learning	20%	50%	80%	100%
STEM programmes with active industry participation in curriculum development	20%	50%	75%	100%
Students completing internships or work-integrated learning before graduation	45%	65%	85%	100%
STEM programmes incorporating entrepreneurship education	40%	70%	90%	100%
Student-led innovation projects completed annually	500	1,500	3,500	6,000
Student startups incubated annually	100	300	700	1,200
Patents and intellectual property generated by students annually	50	120	300	600
Institutions offering interdisciplinary STEM programmes	20%	45%	70%	90%
Programmes incorporating sustainability and green technologies	20%	50%	80%	100%
Institutions providing accessible digital learning resources for students with disabilities	20%	50%	75%	100%
Female enrolment in STEM programmes	35%	40%	45%	50%
Graduate employability within 12 months of graduation	55%	65%	75%	85%
Employer satisfaction with STEM graduates	50%	65%	80%	90%
Graduate digital competency assessment score	50%	65%	80%	90%
Institutions conducting curriculum review every 3–5 years	30%	60%	90%	100%
Programmes meeting national accreditation standards	70%	85%	95%	100%
Programmes achieving international accreditation or benchmarking	10%	20%	40%	60%
National Open Educational Resources (OER) available	500	2,000	5,000	10,000
Micro-credential and stackable certificate programmes available	20	100	250	500
Students earning micro-credentials annually	5,000	30,000	100,000	250,000
Institutions using digital assessment systems	30%	60%	85%	100%

National graduate tracer studies conducted	None	Annual tracer studies established	Graduate outcomes published annually	Real-time national graduate tracking system operational

Implementation Timeline

The implementation (Table 4.5) of the **Curriculum Modernization and Academic Reform** component of the ICT-enabled STEM Transformation Strategy is to be undertaken through a phased approach over a **10-year period (2027–2036)**. This phased implementation (Table allows for systematic policy reforms, institutional capacity building, curriculum redesign, deployment of digital learning technologies, nationwide scaling, and continuous quality improvement. Each phase builds on the achievements of the previous one to ensure sustainability, effective resource utilization, and measurable improvements in STEM education outcomes.

Table 4.5: Implementation Timeline in Phases for Curriculum Modernization and Academic Reform

Phase	Timeline	Key Activities	Major Deliverables
Phase I: Policy Development, Planning and Baseline Assessment	**2027**	Conduct national baseline assessment of STEM curricula and digital readiness. Develop national curriculum modernization policy and implementation guidelines. Establish National Curriculum Modernization Steering Committee. Review regulatory frameworks and quality standards. Mobilize funding and partnerships. Develop Monitoring, Evaluation, Accountability and Learning (MEAL) framework.	National baseline report. Policy and implementation framework approved. Governance structure established. National implementation roadmap completed.
Phase II: Curriculum Review and Capacity Building	**2028–2029**	Review and redesign STEM curricula across universities, polytechnics, and colleges of education. Introduce competency-based and outcome-based education. Develop new courses in AI, Data Science, Robotics, IoT, Cybersecurity, Green Technologies, and Entrepreneurship. Train academic staff in digital pedagogy and curriculum design. Develop digital learning resources and Open Educational Resources (OER).	Revised STEM curricula approved Faculty trained in digital teaching. Digital course materials developed. Competency-based curricula operational.
Phase III: ICT Integration and Pilot Implementation	**2030–2031**	Deploy Learning Management Systems (LMS). Establish virtual laboratories and simulation facilities. Pilot blended learning and digital assessment systems. Introduce micro-credentials and stackable certificates. Strengthen industry partnerships and work-integrated learning. Launch interdisciplinary STEM programmes.	LMS operational in participating institutions. Virtual laboratories established. Digital assessments implemented. Pilot institutions successfully delivering modernized curricula.

Phase IV: National Scale-up and Institutionalization	**2032–2034**	Expand implementation to all public and private tertiary institutions. Scale up industry internships and entrepreneurship programmes. Establish National Open Educational Resources repository. Strengthen quality assurance and accreditation systems. Conduct national graduate tracer studies. Promote inclusive and gender-responsive STEM education.	Nationwide implementation achieved. Industry collaboration institutionalized. National OER platform operational. Graduate tracking system established.
Phase V: Consolidation, Innovation and Global Competitiveness	**2035–2036**	Conduct comprehensive impact evaluation. Benchmark programmes against international standards. Pursue international accreditation. Institutionalize continuous curriculum review every 3–5 years. Strengthen lifelong learning and professional certification programmes. Update curricula to reflect emerging technologies and future workforce needs.	Comprehensive impact assessment completed. Internationally benchmarked STEM programmes. Sustainable curriculum review system established. Globally competitive and digitally enabled STEM education system.

Expected Outcomes

A. Capacity and Competence of STEM Academia

1. Increased percentage of STEM academics trained in digital pedagogy and EduTech tools across Nigerian universities.
2. A measurable improvement in the digital and pedagogical competence of STEM faculty, evidenced by pre- and post-training assessments.
3. A certified, professionally developed STEM academic workforce, with teaching certification becoming a standard requirement for career progression and promotion.
4. Reduced resistance to ICT integration among STEM faculty through sustained coaching and mentoring.

B. Institutional Infrastructure and Enabling Environment

5. Establishment of functional Teaching and Learning Centres (TLCs) in STEM faculties across participating universities, serving as hubs for continuous upskilling, coaching, and mentoring.
6. Improved ICT infrastructure in STEM faculties, including reliable internet connectivity, faculty-wide Wi-Fi, smart classrooms, virtual laboratories, and access to digital libraries and Learning Management Systems (LMS).
7. A standardised and monitored framework for continuous professional development (CPD) embedded within university policy.

C. Student Learning Outcomes and Retention

8. Improved student learning outcomes in STEM programmes, reflected in higher academic performance, deeper conceptual understanding, and stronger problem-solving skills.
9. Increased retention and completion rates in STEM programmes, particularly among female students, through more engaging, technology-enabled learning environments.

10. Enhanced digital literacy and computational skills among STEM undergraduates, making them competitive in the modern workforce.
11. Greater student engagement through flipped classroom models, blended learning, and innovative, competency-based assessment approaches.

D. Research Output and Postgraduate Development

12. Increased PhD completion rates through the introduction of online monitoring frameworks and co-supervision models (international and in-country sandwich programmes).
13. Improved quality and quantity of STEM research output from both academics and postgraduate students, facilitated by ICT-integrated research practices.
14. Early development of research competence among undergraduates through the integration of teaching and research activities at the foundational level.

E. Quality Assurance and Recognition

15. Establishment of a teaching excellence recognition and reward system that incentivises high-quality, innovative pedagogy in STEM faculties.
16. Alignment of STEM teaching and learning standards in Nigerian universities with global best practices, enhancing the international competitiveness of graduates and researchers.
17. A documented and replicable model of ICT-driven STEM education reform that can be scaled across Nigerian universities.

F. Gender Inclusion

18. Narrowed gender gap in STEM participation and retention, with measurable increases in the enrolment, persistence, and performance of female students in STEM programme

4.2 Definition of New STEM Programmes for the Future

The rapid pace of technological advancement—including artificial intelligence (AI), robotics, quantum technologies, biotechnology, advanced manufacturing, cybersecurity, renewable energy, data science, and climate technologies is fundamentally transforming the nature of work and the competencies required of graduates. Therefore, future Future STEM programmes have evolved beyond traditional science and engineering degrees into hybrid, technology-driven, problem-solving disciplines aligned with global economic shifts. These programmes are characteristically digital and AI-driven, interdisciplinary, problem-focused, sustainability-oriented, and skill-based rather than purely credential-focused.

For Nigeria, defining new STEM programmes represents an opportunity to reposition higher education as a catalyst for economic diversification, industrialization, technological self-reliance, and national competitiveness. It supports the country's aspirations under national development frameworks by producing graduates with competencies required in strategic sectors such as digital technologies, clean energy, precision agriculture, advanced healthcare, smart manufacturing, aerospace, geospatial technologies, fintech, and environmental sustainability. The strategy also promotes flexible curriculum models that incorporate work-

integrated learning, industry projects, digital learning platforms, stackable credentials, and multidisciplinary research, inclusive access, ensuring graduates remain adaptable in a rapidly evolving labour market.

Global Emerging new STEM Programme Areas

Table 4.6 is a comprehensive list of **future-oriented STEM programme areas** that Nigerian higher education institutions can develop under the **ICT-enabled STEM Transformation Strategy for Higher Education in Nigeria**. These programmes align with emerging technologies, national development priorities, the Fourth Industrial Revolution (4IR), the Fifth Industrial Revolution (5IR), the African Union Agenda 2063, the UN Sustainable Development Goals (SDGs), and future labour market demands

Table 4.6: Future-Oriented STEM Programmes for Nigeria's Higher Education

STEM Area	Potential Degree/Specialization Programmes	Priority Sector
Digital Economy & ICT (10 programmes)		
Artificial Intelligence	B.Sc./M.Sc. Artificial Intelligence, Applied AI, AI Engineering	Digital Economy
Data Science	Data Science, Big Data Analytics, Predictive Analytics	ICT
Machine Learning	Machine Learning Engineering	ICT
Cloud Computing	Cloud Systems Engineering	ICT
Human-Computer Interaction	Human-Centred Computing	ICT
Software Engineering for AI	Intelligent Software Systems	ICT
Quantum Computing	Quantum Computing and Quantum Information Science	Advanced Computing
Edge Computing	Edge and Distributed Computing	Telecommunications
Internet of Things (IoT)	Internet of Things Engineering	Smart Infrastructure
Extended Reality	Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR)	Education/Industry
Cybersecurity & National Security (2 programmes)		
Cybersecurity	Cybersecurity and Digital Forensics	National Security
Drone Technology	UAV Engineering	Agriculture/Security
Finance & FinTech (2 programmes)		
Blockchain Technology	Blockchain Engineering, Distributed Ledger Systems	Finance
FinTech	Financial Technology	Finance
Health & Biotechnology (10 programmes)		
Bioinformatics	Computational Biology and Bioinformatics	Health
Computational Biology	Systems Biology	Biotechnology
Genomics	Genomics and Precision Medicine	Healthcare
Synthetic Biology	Synthetic Biology	Biotechnology
Biotechnology	Industrial Biotechnology	Agriculture/Health
Biomedical Engineering	Biomedical Systems Engineering	Healthcare
Tissue Engineering	Regenerative Medicine	Healthcare
Health Informatics	Digital Health Systems	Healthcare
Medical Data Science	Healthcare Analytics	Health

Systems Biology	Integrated Biological Systems	Health
Advanced Manufacturing & Industry (11 programmes)		
Nanotechnology	Nanoscience and Nanotechnology	Advanced Materials
Advanced Materials Science	Smart Materials Engineering	Manufacturing
Additive Manufacturing	3D Printing Technology	Industry
Advanced Manufacturing	Smart Manufacturing Systems	Industry 4.0
Mechatronics	Mechatronics Engineering	Manufacturing
Industrial Automation	Automation and Control Systems	Industry
Robotics	Robotics Engineering, Intelligent Robotics	Manufacturing
Digital Twin Technology	Digital Twin Engineering	Smart Manufacturing
Digital Manufacturing	Industry 4.0 Manufacturing	Manufacturing
Sustainable Chemical Engineering	Sustainable Process Engineering	Manufacturing
Engineering Management	Technology Management	Industry
Energy, Climate & Environment programmes		
Renewable Energy Engineering	Solar, Wind and Hydro Engineering	Energy
Hydrogen Energy	Hydrogen Technology	Clean Energy
Energy Storage	Battery Technology and Energy Storage Systems	Energy
Smart Grid Engineering	Intelligent Power Systems	Energy
Carbon Capture	Carbon Capture and Storage Technology	Climate
Climate Science	Climate Change Science	Environment
Climate Technology	Climate Technology and Innovation	Sustainability
Environmental Informatics	Environmental Data Science	Environment
Circular Economy Engineering	Circular Economy and Resource Recovery	Sustainability
Waste-to-Energy Engineering	Waste Valorisation Technology	Waste Management
Green Chemistry	Green Chemistry and Sustainable Chemical Technology	Chemicals
Water Science	Water Security and Water Resources Engineering	Water
Agriculture & Food Security (4 programmes)		
Precision Agriculture	Digital Agriculture	Agriculture
Smart Agriculture	Agricultural Robotics	Agriculture
Agricultural Biotechnology	Agri-biotechnology	Agriculture
Food Technology	Food Innovation and Safety	Food Security
Aerospace, Space & Transportation (5 programmes)		
Space Science	Space Science and Technology	Aerospace
Satellite Engineering	Satellite Systems Engineering	Space
Geospatial Science	GIS and Remote Sensing	Planning
Aerospace Engineering	Aerospace Systems Engineering	Aviation
Autonomous Systems	Autonomous Vehicles and Intelligent Systems	Transportation
Blue Economy (2 programmes)		

Marine Technology	Marine Engineering Technology	Blue Economy
Ocean Science	Marine and Coastal Science	Blue Economy
Infrastructure & Urban Development (3 programmes)		
Smart Cities	Smart City Engineering	Urban Development
Infrastructure Informatics	Intelligent Infrastructure Systems	Construction
Construction Technology	Digital Construction Engineering	Infrastructure
Science, Research & Mathematics (6 programmes)		
Computational Mathematics	Applied Computational Mathematics	Mathematics
Computational Physics	Computational Physics	Science
Computational Chemistry	Computational Chemistry	Science
Systems Engineering	Complex Systems Engineering	Cross-sector
High Performance Computing	Supercomputing and HPC	Research
Science Communication	Science Communication and Public Engagement	Research
Education (2 programmes)		
STEM Education Technology	Digital STEM Education	Education
Learning Analytics	Educational Data Analytics	Education
Governance, Policy & Society (6 programmes)		
Computational Social Science	Computational Policy Analytics	Governance
Ethical AI	AI Ethics and Responsible Innovation	Governance
Technology Policy	Science, Technology and Innovation Policy	Policy
Digital Governance	Digital Government Systems	Public Sector
Disaster Risk Science	Disaster Analytics and Resilience	Emergency Management
Digital Humanities (STEM Interface)	Digital Heritage Technologies	Interdisciplinary
Business & Innovation (1 programme)		
Innovation Management	Innovation and Entrepreneurship	Business

Vision

“To create a dynamic higher education system that continuously develops cutting-edge STEM programmes aligned with emerging technologies, future workforce demands, and sustainable national development”.

Mission

“To design, implement, and continuously modernize interdisciplinary STEM programmes that integrate emerging technologies, digital competencies, entrepreneurship, research, industry collaboration, and experiential learning, thereby preparing graduates with the knowledge, skills, creativity, and adaptability required to thrive in the Fourth and Fifth Industrial Revolutions and contribute to Nigeria's economic competitiveness and sustainable development.”

Strategic Goals

The strategic goals for the **Definition of New STEM Programmes for the Future** component presented in Table 4.7 are designed to guide Nigeria's higher education institutions in developing innovative, future-oriented STEM programmes that respond to rapid technological change, evolving workforce demands, and national development priorities. These goals focus on establishing academic programmes in emerging fields, promoting interdisciplinary and competency-based learning, strengthening industry partnerships, embedding digital technologies and entrepreneurship into curricula, and ensuring continuous curriculum renewal through evidence-based foresight and labour market intelligence.

The desired outcomes are to produce graduates with future-ready competencies, enhance the relevance and quality of STEM education, improve graduate employability, stimulate research and innovation, and strengthen Nigeria's capacity to compete in the global knowledge economy. Collectively, these goals will enable higher education institutions to become drivers of scientific advancement, technological innovation, industrial transformation, and sustainable socio-economic development while positioning Nigeria as a regional leader in next-generation STEM education.

Table 4.7: Strategic Goals and Desired Outcomes for implementing New STEM Programmes

Strategic Goal	Desired Outcomes
1. Develop Future-Oriented STEM Academic Programmes	New undergraduate and postgraduate programmes established in emerging STEM disciplines. Programmes aligned with global technological trends and Nigeria's development priorities. Increased enrolment in high-demand STEM fields.
2. Align STEM Programmes with Industry and Labour Market Needs	Curricula developed in collaboration with industry, professional bodies, and employers. Graduates possess skills required for current and future jobs. Reduced graduate unemployment and improved employability.
3. Promote Interdisciplinary and Convergent STEM Education	Increased number of multidisciplinary programmes integrating engineering, computing, life sciences, environmental sciences, business, and social sciences. Graduates capable of solving complex societal challenges through systems thinking.
4. Integrate Emerging and Disruptive Technologies into Academic Programmes	Artificial Intelligence (AI), Machine Learning, Robotics, Internet of Things (IoT), Quantum Computing, Blockchain, Biotechnology, Digital Manufacturing, Cybersecurity, and Data Science embedded across STEM curricula. Graduates equipped with advanced digital competencies.
5. Embed Entrepreneurship, Innovation and Commercialization Skills	Entrepreneurship incorporated into all STEM programmes. Increased student-led startups, patents, prototypes, and technology commercialization. Strong innovation and entrepreneurial culture across institutions.
6. Institutionalize Competency-Based and Flexible Learning Pathways	Competency-based curricula adopted nationwide. Introduction of stackable certificates, micro-credentials, digital badges, and modular degree pathways. Improved lifelong learning opportunities for students and professionals.
7. Strengthen Industry-Academia Collaboration in Programme Development	Active participation of industry experts in curriculum design, teaching, internships, and programme review. Increased work-integrated learning and industrial attachments. Enhanced graduate workplace readiness.
8. Mainstream Digital Learning and ICT-Enabled Programme Delivery	Blended and online STEM programmes widely available. Greater use of virtual laboratories, simulations, AI-assisted learning, digital twins, and immersive technologies. Increased access to quality STEM education nationwide.

9. Promote Inclusion, Gender Equity and Regional Balance in Emerging STEM Fields	Increased participation of women, persons with disabilities, and underserved regions in new STEM programmes. Reduced gender and geographical disparities in advanced STEM education.
10. Establish Responsive Curriculum Review and Foresight Mechanisms	Institutionalized horizon scanning and labour market intelligence systems. Regular curriculum review cycles informed by technological trends and national priorities. Programmes remain relevant to evolving industry needs.
11. Strengthen Research Integration within New STEM Programmes	Students engaged in interdisciplinary research addressing national challenges. Increased research publications, patents, innovation outputs, and industry-funded projects. Stronger research-to-commercialization pipeline.
12. Position Nigeria as a Regional Hub for Future STEM Education	Nigerian universities become recognized centres for emerging STEM disciplines. Increased international collaborations, student mobility, and research partnerships. Enhanced global competitiveness and institutional rankings.

Strategic Interventions

The strategic activities and programmes under the **Definition of New STEM Programmes for the Future** component provide the implementation roadmap for transforming STEM education in Nigeria's higher education system Table 4.8. They are designed to support the development, accreditation, and continuous improvement of innovative academic programmes that are responsive to emerging technologies, industry needs, national development priorities, and global trends. These activities translate the strategic goals into coordinated actions that enable institutions to design future-oriented curricula, strengthen teaching and learning, and produce graduates with the competencies required for the digital economy and the future of work.

The activities emphasize a holistic approach to programme development, encompassing curriculum innovation, industry engagement, faculty capacity building, digital transformation, quality assurance, research integration, entrepreneurship, and inclusive access. They also promote institutional collaboration with government agencies, industry, professional bodies, and international partners to ensure that newly developed STEM programmes remain relevant, competitive, and aligned with labour market demands. Through flagship initiatives such as curriculum foresight, competency-based education, micro-credentials, digital learning, work-integrated learning, and centres of excellence, the strategy seeks to create an agile and resilient higher education ecosystem capable of adapting to rapid technological and socio-economic

Table 4.8: Activities, Programmes and Key Performance Indicators (KPIs) for the Definition of New STEM Programmes for the Future

Strategic Goal	Strategic Activities	Programmes/Initiatives	Key Performance Indicators (KPIs)
1. Develop Future-Oriented STEM Academic Programmes	Conduct foresight studies to identify emerging STEM fields; develop and approve new curricula	National Future STEM Programme Development Initiative	Number of new STEM programmes developed and accredited. Number of institutions offering future-oriented programmes. Percentage of programmes aligned with national priorities
2. Align new STEM Programmes with Industry and	Establish industry curriculum advisory boards; conduct labour market assessments; co-	Industry-Responsive Curriculum Development Programme	Number of industry partnerships. Percentage of programmes co-developed with industry. Graduate

Labour Market Needs	design curricula with employers		employment rate within 12 months. Employer satisfaction index
3. Promote Interdisciplinary STEM Education	Develop multidisciplinary degree programmes; encourage joint teaching and cross-faculty collaboration	Interdisciplinary STEM Education Programme	Number of interdisciplinary programmes established. Student enrolment in interdisciplinary programmes. Number of joint academic departments and research projects
4. Establish Continuous Curriculum Review Mechanisms for New STEM programmes	Institutionalize periodic curriculum review using labour market intelligence and technology foresight	National STEM Curriculum Foresight Observatory	Curriculum review cycle compliance. Number of foresight reports produced Number of programmes updated every 3–5 years
5. Strengthen Research Integration in STEM Programmes	Embed undergraduate research, innovation projects, capstone design, and industry-sponsored research	Research-Integrated STEM Education Initiative	Student research projects completed. Publications and conference presentations. Industry-sponsored student projects Research commercialization outputs
5. Expand International Collaboration and Benchmarking	Develop joint degrees, faculty exchanges, student mobility, international accreditation, and collaborative curriculum development	Global STEM Partnership Programme	Number of international partnerships. Joint degree programmes established. Student and faculty exchange numbers. International programme accreditation obtained
6. Build Faculty Capacity for Emerging STEM Disciplines	Recruit experts; train faculty in new technologies, curriculum design, AI, digital pedagogy, and interdisciplinary teaching	Future STEM Faculty Development Programme	Faculty trained annually. Industry certifications obtained by faculty. Number of visiting international experts. Faculty competency improvement scores
7. Strengthen Quality Assurance and Accreditation	Develop national quality standards for future STEM programmes; strengthen programme accreditation	Future STEM Quality Assurance Framework	Accreditation rate of new programmes. Compliance with national standards, Student satisfaction ratings External quality assessment scores
15. Establish National Centres for Emerging STEM Disciplines	Create specialized centres for AI, Quantum Technologies, Renewable Energy, Biotechnology, Climate Science, Smart Agriculture, and Advanced Manufacturing	National Emerging STEM Centres Programme	Number of centres established. Research outputs from centres Industry collaborations. Graduate enrolment in specialized centres

Responsibilities

Sames as in Table 4.9. However, to accelerate implementation for new STEM programmes for the future, the following flagship programmes are recommended:

Table 4.9: Flagship National Programmes to accelerate New STEM Programmes

Programme	Purpose
National Future STEM Programme Development Initiative	Design and launch new degree programmes in emerging disciplines.
Emerging Technologies Curriculum Integration Initiative	Mainstream AI, data science, robotics, cybersecurity, biotechnology, and digital manufacturing across STEM curricula.
National Micro-Credential and Flexible Learning Initiative	Introduce modular, stackable, and lifelong learning pathways.
Industry-Responsive Curriculum Development Programme	Align curricula with labour market and industry needs.
National STEM Internship and Apprenticeship Programme	Expand experiential learning and graduate employability.
Digital STEM Learning Programme	Scale ICT-enabled teaching, virtual laboratories, and AI-supported learning.
Inclusive Future STEM Programme	Improve participation of women, persons with disabilities, and underserved regions.
National STEM Curriculum Foresight Observatory	Monitor global technological trends and recommend periodic curriculum updates.
Future STEM Faculty Development Programme	Build faculty expertise in emerging technologies and innovative pedagogy.
National Emerging STEM Centres Programme	Develop centres of excellence in strategic future STEM disciplines.

Key Performance Indicators

Same as Table 4.4.

Timelines

Same as Table 4.5.

Expected Outcomes

Successful implementation of the **Definition of New STEM Programmes for the Future** component is expected to transform Nigeria's higher education landscape by ensuring that STEM programmes remain relevant, innovative, and responsive to emerging technologies, industry demands, and national development priorities. The following outcomes and benefits are anticipated.

Table 4.10: Expected Outcomes and Benefits to Nigeria

Expected Outcome	Benefits for Nigeria
1. Modernized and Future-Oriented STEM Curricula	Higher education institutions offer globally competitive programmes that reflect emerging technologies and future workforce needs.
2. Increased Graduate Employability	Graduates possess industry-relevant technical, digital, entrepreneurial, and problem-solving skills, leading to higher employment and self-employment rates.
3. Stronger Digital Economy Workforce	Nigeria develops a critical mass of professionals in AI, data science, cybersecurity, robotics, biotechnology, renewable energy, and other strategic sectors.

4. Enhanced Innovation and Entrepreneurship	Increased creation of technology startups, patents, prototypes, spin-off companies, and commercialization of research outputs.
5. Improved University–Industry Collaboration	Strong partnerships ensure curricula remain relevant while expanding internships, apprenticeships, industrial research, and graduate recruitment opportunities.
6. Greater Research and Technology Development Capacity	Higher-quality research addressing national challenges in healthcare, agriculture, manufacturing, energy, water, and climate resilience.
7. Increased International Competitiveness	Nigerian universities attract international collaborations, research funding, faculty exchanges, and foreign students while improving global rankings.
8. Stronger Industrialization and Economic Diversification	Availability of highly skilled professionals accelerates growth in manufacturing, digital services, healthcare, agriculture, renewable energy, aerospace, and advanced technologies.
9. Increased Adoption of Emerging Technologies	Greater deployment of AI, IoT, automation, digital manufacturing, biotechnology, blockchain, and smart systems across the economy.
10. Improved STEM Participation and Inclusion	Greater enrolment of women, persons with disabilities, and students from underserved regions in emerging STEM disciplines.
11. Flexible Lifelong Learning Opportunities	Professionals continually upgrade skills through micro-credentials, stackable certificates, and digital learning, improving workforce adaptability.
12. Stronger National Innovation Ecosystem	Enhanced collaboration among universities, industry, government, investors, and innovation hubs strengthens the national innovation system.
13. Improved Quality Assurance and Academic Excellence	Continuous curriculum review and accreditation ensure programmes meet international quality standards.
14. Increased Foreign Direct Investment (FDI)	Availability of a highly skilled STEM workforce attracts multinational companies and technology investments into Nigeria.
15. Enhanced National Resilience and Sustainable Development	STEM graduates develop innovative solutions to climate change, food security, public health, energy access, environmental sustainability, and disaster management.

4.3 Preparation of incoming students

In Nigeria, many students entering universities, polytechnics, and colleges of education face significant learning gaps resulting from disparities in the quality of basic and secondary education, inadequate laboratory exposure, limited access to digital technologies, and insufficient career guidance. These challenges contribute to high failure rates in first-year STEM courses, prolonged time-to-degree, low retention, and limited participation in research and innovation activities. Key factors contributing to poor STEM readiness include weak foundational skills in mathematics and science, inadequate study habits, poor met cognitive skills, non-inclusive learning environments, cultural expectations, gender stereotyping, and the absence of visible role models and mentors. Addressing these requires deliberate intervention at both pre-university and post-admission levels. Preparing students before admission and during the transition into higher education is therefore essential to improving learning outcomes and maximizing investments in STEM education.

This strategic component seeks to establish a coordinated national framework that bridges the transition between secondary and tertiary education through pre-university STEM enrichment programmes, digital learning platforms, bridging courses in mathematics and sciences, coding and computational thinking programmes, academic orientation, career counselling, entrepreneurship exposure, and foundational research skills. It also emphasizes equitable access by providing targeted support for female students, learners from underserved

communities, students with disabilities, and other disadvantaged groups to ensure that no talented learner is left behind.

Ultimately, the Preparation of Incoming Students component aims to create a robust pipeline of well-prepared, motivated, and digitally competent learners who can successfully transition into higher education, excel in STEM disciplines, contribute to cutting-edge research and innovation, and drive Nigeria's transformation into a knowledge-based, technology-driven economy. By strengthening student readiness at the entry point, Nigeria can improve STEM retention, increase graduation rates, enhance graduate employability, and build the skilled human capital required to achieve national aspirations under the **Nigeria Education Sector Renewal Initiative (NESRI)**, the **National Digital Economy Policy and Strategy**, the **National Science, Technology and Innovation Policy**, and the **Sustainable Development Goals (SDGs 4, 5, 8, and 9)**.

Vision

"To develop a nationally inclusive pipeline of academically prepared, digitally empowered, and innovation-oriented students who successfully transition into tertiary STEM education and become the next generation of scientists, engineers, technologists, innovators, and entrepreneurs driving Nigeria's sustainable development and global competitiveness".

Mission

"To provide comprehensive pre-entry academic preparation, digital skills development, career guidance, mentorship, and transition support through collaborative partnerships among government, schools, higher education institutions, industry, and communities, ensuring that every incoming STEM student is equipped with the knowledge, competencies, and mindset needed for success in higher education, research, innovation, entrepreneurship, and national development."

Strategy Goals

The following strategic goals Table 4.11 are designed to achieve the vision of developing a nationally inclusive pipeline of academically prepared, digitally empowered, and innovation-oriented students for Nigeria's ICT-enabled STEM Transformation.

Table 4.11: Strategic Goals and Desired Expectations for the Preparation of Incoming Students

Strategic Goal	Desired Expectations (Outcomes)
1. Strengthen STEM Readiness Before Admission	Incoming students possess strong foundational knowledge in mathematics, sciences, communication, and analytical reasoning, reducing the need for remedial education and improving first-year academic performance.
2. Bridge the Transition Between Secondary and Tertiary Education	A seamless transition system is established through bridging programmes, orientation courses, and standardized pre-university preparation, leading to improved adaptation to tertiary learning environments.
3. Develop Digital and Computational Competencies	Students enter higher education with essential digital literacy, coding, computational thinking, data literacy, and responsible AI skills required for modern STEM education and future careers.
4. Promote Innovation, Creativity and Problem-Solving Skills	Students demonstrate innovation, critical thinking, design thinking, entrepreneurship, teamwork, and problem-solving capabilities through experiential and project-based learning activities.

5. Enhance Career Awareness and STEM Motivation	Students make informed academic and career choices through structured career guidance, mentorship, and exposure to emerging STEM fields, resulting in increased enrolment and retention in priority STEM disciplines.
6. Improve Equity, Inclusion and Access	Female students, learners with disabilities, and students from rural, disadvantaged, and conflict-affected communities receive targeted preparation and support, reducing disparities in STEM participation and success.
7. Strengthen Collaboration Between Secondary and Tertiary Institutions	Strong partnerships among secondary schools, tertiary institutions, examination bodies, industry, and government agencies ensure curriculum alignment, shared standards, and smoother student progression.
8. Foster Research Awareness and Scientific Curiosity	Students develop an early appreciation of scientific inquiry, research ethics, laboratory safety, and evidence-based problem-solving, encouraging future participation in research and innovation.
9. Promote Student Well-being and Learning Resilience	Students acquire effective study habits, time management, communication, emotional resilience, and psychosocial skills that support academic success and reduce dropout rates.
10. Establish a National STEM Student Preparation Framework	A coordinated national framework for pre-entry STEM preparation is implemented across universities, polytechnics, colleges of education, and technical institutions with common quality standards and monitoring mechanisms.
11. Integrate Emerging Technologies into Student Preparation	Incoming students gain foundational exposure to artificial intelligence, robotics, cybersecurity, biotechnology, renewable energy, Internet of Things (IoT), and data science, preparing them for future-oriented STEM programmes.
12. Build a Sustainable National STEM Talent Pipeline	Nigeria produces a larger pool of well-prepared, high-performing STEM students who progress into advanced education, research, innovation, entrepreneurship, and the high-skilled workforce needed for national development.

Strategic Activities

The strategic activities under the **Preparation of Incoming Students** component are designed to provide a structured and comprehensive pathway that equips prospective STEM students with the knowledge, skills, attitudes, and competencies required for successful transition into tertiary education. These activities address academic preparedness, digital literacy, career orientation, innovation, entrepreneurship, and psychosocial readiness while ensuring equitable access to quality STEM education across Nigeria Table 4.12.

The activities focus on strengthening foundational competencies in mathematics, science, technology, and communication through bridging programmes, diagnostic assessments, STEM boot camps, digital learning platforms, and experiential learning opportunities. They also introduce students to emerging technologies such as artificial intelligence, coding, robotics, data science, cybersecurity, and the Internet of Things (IoT), preparing them for the demands of modern STEM curricula and the future workforce.

In addition, the component emphasizes mentorship, career guidance, student well-being, laboratory preparedness, and entrepreneurship development to foster confidence, resilience, creativity, and problem-solving abilities among incoming students. Strong partnerships among secondary schools, tertiary institutions, government agencies, industry, professional bodies, and development partners will ensure curriculum alignment, quality assurance, and a seamless transition from secondary to higher education.

Collectively, these strategic activities shall establish a nationally coordinated STEM student preparation system that improves first-year academic performance, reduces dropout rates, promotes gender equity and inclusion, strengthens the STEM talent pipeline, and supports Nigeria's ambition to build a globally competitive, innovation-driven, and digitally enabled knowledge economy.

Table 4.12: Strategic Activities, Programmes and Key Performance Indicators (KPIs) for the Preparation of Incoming Students Component

Strategic Activity	Programme/Initiative	Key Performance Indicators (KPIs)
1. Establish National STEM Readiness Programme	National Pre-University STEM Readiness Programme	National STEM readiness framework developed and approved. Number of institutions implementing the programme. Percentage of incoming students completing the readiness programme
2. Implement STEM Bridging Courses	Mathematics, Physics, Chemistry, Biology, ICT and English Bridging Programme	Number of bridging courses offered. Percentage of admitted students completing bridging courses. Improvement in diagnostic assessment scores. Reduction in first-year failure rates
3. Introduce Digital Literacy and AI Foundation Training	Digital Skills for STEM Initiative	Percentage of incoming students certified in digital literacy. Number of students trained in coding, AI, cybersecurity and data literacy. Student digital competency assessment scores
4. Strengthen Career Guidance and STEM Awareness	National STEM Career Orientation Programme	Number of career guidance sessions conducted. Number of students participating. Increase in STEM programme enrolment. Student awareness and satisfaction levels
5. Develop STEM Boot Camps and Summer Schools	National STEM Boot Camps	Number of boot camps organized annually. Number of participating students. Percentage of participants successfully transitioning into STEM programmes
6. Expand Mentorship and Peer Support Systems	National STEM Mentorship Network	Number of mentors recruited. Mentor-to-student ratio. Percentage of first-year students assigned mentors. Student retention rate after first year
7. Promote Innovation and Problem-Based Learning	Innovation Challenge and Design Thinking Programme	Number of innovation competitions organized. Student participation rate Number of student innovation projects developed. Awards and recognitions received
8. Strengthen Laboratory and Practical Readiness	STEM Laboratory Familiarization Programme	Number of laboratory orientation sessions conducted. Percentage of students completing laboratory safety training. Improvement in practical skills assessments
9. Enhance Scientific Communication Skills	Academic Communication and Scientific Writing Programme	Number of students trained Improvement in communication assessment scores. Student presentation and report-writing competency levels
10. Introduce Entrepreneurship and Innovation Orientation	STEM Entrepreneurship Foundation Programme	Number of entrepreneurship workshops conducted .Number of students completing entrepreneurship modules. Student business ideas and prototypes developed
11. Promote Gender Equity and Inclusion	Inclusive STEM Access Programme	Percentage of female participants Participation of students with disabilities and underserved communities. Reduction

		in gender gaps in STEM enrolment and completion
12. Strengthen Secondary–Tertiary Linkages	School-to-University Transition Partnership Programme	Number of secondary schools partnered with tertiary institutions. Number of joint STEM outreach activities. Curriculum alignment initiatives implemented
13. Develop Online Student Preparation Platform	National Digital STEM Learning Portal	Platform operational and accessible nationwide. Number of registered users Course completion rate. User satisfaction index
14. Conduct Diagnostic Assessments for Incoming Students	National STEM Entry Assessment Programme	Percentage of incoming students assessed. Diagnostic reports generated improvements between pre- and post-intervention assessments
15. Build Capacity of Teachers and Programme Facilitators	STEM Readiness Facilitator Development Programme	Number of facilitators trained. Number of certified instructors. Quality assurance ratings of training delivery
16. Implement Student Well-being and Academic Success Programme	First-Year Success and Student Support Initiative	Student counselling participation rate First-year retention rate. Reduction in dropout rates. Student well-being and engagement scores
17. Organize National STEM Competitions	National STEM Olympiads, Robotics and Coding Competitions	Number of competitions held annually Student participation rates. Number of winners advancing to regional and international competitions
18. Establish Monitoring, Evaluation and Learning (MEL) System	STEM Student Readiness Performance Dashboard	National dashboard operational Annual performance reports produced Percentage of institutions submitting data • Evidence of data-driven programme improvements

Responsibilities

Given the cross-cutting nature of student preparation which spans basic education, tertiary education, digital transformation, career development, and industry engagement a coordinated, multi-level approach is essential to ensure effective planning, implementation, monitoring, and continuous improvement. The Responsibility Matrix identifies the lead and supporting institutions responsible for each strategic activity and specifies the appropriate implementation level **National, State, and Institutional**. At the national level, federal ministries and regulatory agencies are responsible for policy formulation, standard setting, quality assurance, resource mobilization, and national coordination. State governments facilitate implementation through coordination with secondary schools and local stakeholders, while universities, polytechnics, colleges of education, and other tertiary institutions are responsible for delivering programmes directly to students.

The matrix also recognizes the important contributions of industry, professional bodies, research institutions, development partners, civil society organizations, and the private sector in providing technical expertise, mentorship, digital learning resources, internships, funding, and innovation opportunities. This collaborative governance model promotes institutional accountability, strengthens inter-agency coordination, minimizes duplication of efforts, and ensures efficient use of resources.

By assigning clear responsibilities and fostering partnerships across all levels of government and the education sector, the Responsibility Matrix provides a practical implementation framework for achieving the objectives of the **Preparation of Incoming Students** component.

It also supports effective monitoring and evaluation, enhances stakeholder ownership, and contributes to building a sustainable pipeline of well-prepared, digitally competent, and innovation-driven STEM students capable of advancing Nigeria's national development and global competitiveness.

Table 4.13: Responsibility Matrix for the Preparation of Incoming Students Component

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level (National, State, Institutional)
Establish a National STEM Readiness Programme	Federal Ministry of Education (FME); National Universities Commission (NUC)	National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); State Ministries of Education	National, State, Institutional
Develop and implement STEM bridging courses	NUC; NBTE; NCCE	Universities, Polytechnics, Colleges of Education, Professional Bodies	National, Institutional
Introduce Digital Literacy, Coding and AI Foundation Programme	Federal Ministry of Education; Federal Ministry of Communications, Innovation and Digital Economy	National Information Technology Development Agency (NITDA); ICT Academies; Technology Companies	National, State, Institutional
Conduct diagnostic assessments for incoming students	NUC; NBTE; NCCE	Universities, Polytechnics, Colleges of Education, Examination Bodies	National, Institutional
Organize National STEM Boot Camps and Summer Schools	Federal Ministry of Education	State Ministries of Education; Universities; Development Partners; Industry	National, State
Strengthen career guidance and STEM awareness programmes	Federal Ministry of Education	State Ministries of Education; Secondary Schools; Universities; Professional Associations; Industry Partners	National, State, Institutional
Establish STEM mentorship and peer-support programmes	Universities, Polytechnics and Colleges of Education	Alumni Associations; Professional Societies; Industry Mentors; Student Associations	Institutional
Promote innovation, creativity and design-thinking programmes	Universities; NUC	Industry Partners; Innovation Hubs; Research Institutes; Entrepreneurship Centres	Institutional
Introduce laboratory orientation and practical skills programmes	Universities, Polytechnics and Colleges of Education	Laboratory Managers; Research Institutes; Professional Bodies	Institutional
Strengthen scientific communication and academic skills	Universities; Polytechnics; Colleges of Education	Academic Libraries; Communication Centres; Professional Associations	Institutional
Implement entrepreneurship and innovation orientation	Tertiary Education Trust Fund (TETFund); Universities	Entrepreneurship Development Centres; Small and Medium Enterprises Development Agency of Nigeria (SMEDAN); Industry Partners	National, Institutional
Promote gender equity and inclusion initiatives	Federal Ministry of Education	Federal Ministry of Women Affairs; State Ministries; Development Partners; NGOs	National, State, Institutional

Strengthen secondary–tertiary STEM partnerships	Federal Ministry of Education	State Ministries of Education; Secondary Schools; Universities; Examination Bodies	National, State
Develop a National Digital STEM Learning Platform	Federal Ministry of Education; NITDA	NUC; NBTE; NCCE; ICT Companies; Telecommunications Providers	National
Build capacity of STEM readiness facilitators	NUC; NBTE; NCCE	Universities; Colleges of Education; Teacher Training Institutes; Development Partners	National, Institutional
Implement first-year student success and well-being programmes	Universities, Polytechnics and Colleges of Education	Student Affairs Divisions; Counselling Centres; Health Services	Institutional
Organize National STEM competitions, Olympiads and hackathons	Federal Ministry of Education	Professional Societies; Innovation Hubs; Industry Partners; Development Partners	National, State
Establish a Monitoring, Evaluation and Learning (MEL) system	Federal Ministry of Education	NUC; NBTE; NCCE; TETFund; National Bureau of Statistics; Universities	National, Institutional
Mobilize funding and partnerships for student preparation programmes	Federal Ministry of Education	TETFund; Development Partners; Private Sector; Philanthropic Foundations; State Governments	National, State

Key Performance Indicators

The KPIs are designed to assess improvements in student academic readiness, digital competencies, STEM participation, equity and inclusion, transition into tertiary education, and first-year success. They also provide measurable milestones for tracking implementation across national, state, and institutional levels.

The KPI framework (Table 4.14) adopts a phased approach comprising **baseline**, **short-term (Years 1–2)**, **medium-term (Years 3–5)**, and **long-term (Years 6–10)** targets. The baseline represents the situation at the commencement of the strategy (2026), while subsequent targets reflect progressive implementation and scaling. The indicators align with Nigeria's education reform priorities, international best practices, and the monitoring and evaluation framework of the national STEM Transformation Strategy.

Table 4.14: Key Performance Indicators (KPIs) for the Preparation of Incoming Students Component

KPI	Baseline (2026)	Short-Term Target (Years 1–2)	Medium-Term Target (Years 3–5)	Long-Term Target (Years 6–10)
Institutions implementing a standardized STEM readiness programme	0%	30%	70%	100%

Incoming STEM students completing bridging programmes	5%	30%	70%	95%
Students achieving satisfactory STEM readiness assessment scores	40%	55%	75%	90%
First-year STEM course pass rate	60%	70%	80%	90%
First-year STEM retention rate	65%	75%	85%	95%
Students certified in digital literacy before enrolment	10%	40%	75%	100%
Students completing coding and AI foundation training	5%	30%	65%	90%
Secondary schools participating in STEM transition partnerships	10%	35%	70%	100%
Universities, polytechnics and colleges offering STEM boot camps	5%	30%	70%	100%
Incoming students receiving career guidance and orientation	20%	60%	85%	100%
Incoming students assigned mentors	10%	50%	80%	100%
Students participating in STEM innovation competitions	5%	20%	50%	80%
Female participation in STEM readiness programmes	35%	45%	50%	≥50%
Participation of students with disabilities and other underserved groups	5%	15%	30%	50%
Students completing laboratory safety and practical orientation	20%	60%	85%	100%
Students completing entrepreneurship orientation	10%	40%	70%	95%
National Digital STEM Learning Platform operational	Not available	Platform launched	Fully operational in all states	Continuously upgraded and nationally integrated
Registered users on the Digital STEM Learning Platform	0	500,000	2 million	5 million
Institutions conducting annual diagnostic assessments	10%	50%	80%	100%
STEM readiness facilitators trained and certified	200	2,000	5,000	10,000
Student satisfaction with preparation programmes	60%	75%	85%	95%
Annual dropout rate in first-year STEM programmes	20%	≤15%	≤10%	≤5%
States implementing the national STEM preparation framework	5	18	30	37 (36 states + FCT)
National annual STEM readiness performance report published	No	Annual publication initiated	Institutionalized nationwide	Fully integrated into national education reporting

Timelines

The implementation of the **Preparation of Incoming Students** component is to follow a **four-phase approach** to ensure systematic planning, piloting, scaling, institutionalization, and continuous improvement as presented in Table 4.15. The phased implementation recognizes differences in institutional readiness and resource availability while allowing for lessons learned to inform subsequent phases. Each phase builds on the achievements of the previous one, culminating in a fully integrated and sustainable national system for preparing students for STEM education. The implementation timeline aligns with the overall **ICT-enabled STEM Transformation Strategy for Higher Education in Nigeria** and provides clear milestones for national, state, and institutional stakeholders.

Table 4.15: The implementation timeline for the Preparation of Incoming Students

Phase	Timeline	Major Activities	Key Deliverables
Phase I: Planning, Policy Development and Pilot Implementation	2026–2027 (Years 1–2)	Develop the National STEM Student Readiness Framework Establish governance and coordination mechanisms. Design standardized bridging curricula and digital learning resources. Develop diagnostic assessment tools. Launch the National Digital STEM Learning Platform. Pilot STEM bridging programmes, boot camps, mentorship, and career guidance in selected institutions. Train STEM readiness facilitators	National policy and implementation framework approved. Pilot institutions operational. Digital platform launched. Initial cohort of facilitators trained. Baseline data established
Phase II: Expansion and Capacity Building	2028–2030 (Years 3–5)	Expand bridging programmes to additional institutions. Scale digital literacy, coding, AI, and computational thinking programmes. Strengthen secondary–tertiary partnerships nationwide. Expand STEM mentorship and innovation programmes. Increase participation of female students and underserved groups Strengthen monitoring and evaluation systems	Majority of tertiary institutions implementing readiness programmes National mentorship network established Increased student participation in digital and innovation programmes Mid-term performance evaluation completed
Phase III: National Integration and Institutionalization	2031–2033 (Years 6–8)	Achieve nationwide implementation across universities, polytechnics, and colleges of education. Integrate STEM readiness into institutional admission and orientation processes Strengthen quality assurance and accreditation mechanisms Enhance industry participation and experiential learning opportunities Upgrade digital learning infrastructure and analytics systems	National implementation achieved. STEM readiness integrated into institutional practices. Strong industry partnerships established Quality assurance mechanisms fully operational

Phase IV: Sustainability, Innovation and Continuous Improvement	2034–2035 (Years 9–10)	Review and update STEM readiness curricula based on emerging technologies Institutionalize continuous professional development for facilitators. Strengthen data-driven decision-making through learning analytics. Conduct impact evaluations and policy reviews. Develop sustainability and long-term financing mechanisms	Sustainable national STEM preparation system established. Long-term financing strategy implemented. Final impact evaluation completed Continuous improvement framework institutionalized

4.3.1 Expected Outcome

Expected Outcomes by Phase

Phase I: National standards, governance structures, pilot programmes, and digital infrastructure are established.

Phase II: Student preparation programmes are expanded nationwide, with significant improvements in academic readiness, digital competencies, and inclusion.

Phase III: STEM readiness becomes an integral component of tertiary education, supported by strong partnerships, quality assurance, and industry engagement.

Phase IV: Nigeria operates a mature, sustainable, and continuously evolving STEM student preparation system that consistently produces well-prepared learners equipped for higher education, innovation, and the future workforce.

4.3.2 Expected Impact by the End of the Strategy

By the conclusion of the implementation period, the KPI framework is expected to demonstrate that:

1. All tertiary institutions implement a standardized STEM student preparation programme.
2. Nearly all incoming STEM students complete academic and digital readiness programmes before commencing their studies.
3. First-year academic performance and retention in STEM programmes improve substantially.
4. Every incoming STEM student acquires foundational digital, coding, and AI competencies.
5. Strong partnerships exist between secondary and tertiary institutions in all states and the Federal Capital Territory.
6. Female students, learners with disabilities, and students from underserved communities participate equitably in STEM preparation programmes.
7. National digital learning platforms provide accessible, high-quality preparatory resources to millions of learners.

8. Nigeria develops a sustainable pipeline of academically prepared, digitally competent, and innovation-oriented STEM students who are well positioned to contribute to research, industrial development, entrepreneurship, and national competitiveness.

4.4 Recruitment of qualified STEM academics

Introduction

The recruitment of qualified STEM academics is a cornerstone of Nigeria's ICT-enabled STEM Transformation Strategy for Higher Education. Achieving world-class STEM education, research, and innovation requires universities, polytechnics, colleges of education, and other tertiary institutions to attract, recruit, and retain highly qualified academic staff with expertise in emerging science and technology disciplines. As Nigeria seeks to build a knowledge-driven economy, strengthen industrial competitiveness, and accelerate digital transformation, there is an urgent need to address persistent shortages of qualified STEM faculty, ageing academic workforce, brain drain, uneven distribution of specialists across institutions, and limited expertise in frontier fields such as artificial intelligence, robotics, cybersecurity, biotechnology, renewable energy, quantum technologies, advanced manufacturing, and data science.[80]

This strategic component aims to establish a modern, transparent, merit-based, and globally competitive recruitment system that enables Nigerian higher education institutions to attract the best talent from within the country and the international academic community, including members of the Nigerian diaspora. Recruitment policies will prioritize excellence in teaching, research, innovation, industry experience, digital competence, interdisciplinary collaboration, and commitment to inclusive education. The strategy also promotes gender equity and balanced regional representation to ensure that all institutions have access to high-quality STEM educators.

The strategy further recognizes that recruitment alone is insufficient without creating an enabling environment that offers competitive remuneration, modern research infrastructure, digital teaching tools, career progression opportunities, international collaborations, and continuous professional development. Consequently, recruitment initiatives will be integrated with staff retention, mentorship, performance management, and research funding mechanisms to build a sustainable pipeline of academic talent capable of producing globally competitive graduates, conducting impactful research, and driving innovation ecosystems.

Ultimately, strengthening the recruitment of qualified STEM academics will enhance teaching quality, improve research productivity, foster stronger university-industry partnerships, increase international competitiveness of Nigerian institutions, and support the development of the highly skilled workforce required to achieve Nigeria's long-term economic diversification and sustainable development objectives in the digital age.[81]

Vision

[80] National Universities Commission. (2024). ICT-STEM Blueprint for Nigerian Universities. National Universities Commission, Abuja, Nigeria.
[81] African Union. (2020). Digital Transformation Strategy for Africa (2020–2030). Addis Ababa, Ethiopia.

“To build a globally competitive, diverse, and future-ready STEM academic workforce that drives excellence in teaching, research, innovation, entrepreneurship, and digital transformation across Nigeria's higher education institutions.”

Mission

“To establish transparent, merit-based, inclusive, and globally competitive recruitment systems that attract, develop, and retain outstanding STEM academics through enabling policies, competitive incentives, continuous professional development, and strategic national and international partnerships.”

Strategic Goals

The Recruitment of Qualified STEM Academics component seeks to build a high-quality, diverse, and sustainable academic workforce capable of delivering world-class STEM education, research, innovation, and entrepreneurship across Nigeria's higher education institutions especially in the STEM programmes for the future.

Table 4.16: Strategic Goals and Desired Outcomes for the Recruitment of Qualified STEM Academics

Strategic Goal	Desired Outcomes
1. Strengthen the National STEM Academic Workforce	Increased recruitment of highly qualified STEM academics across universities, polytechnics, and colleges of education, leading to improved staff-to-student ratios and enhanced teaching quality.
2. Establish a Transparent and Merit-Based Recruitment System	Standardized, digital, and competency-based recruitment processes that promote fairness, accountability, and excellence in hiring across all tertiary institutions.
3. Attract Global and Diaspora STEM Talent	Increased participation of Nigerian diaspora scholars and international experts through visiting professorships, joint appointments, returnee fellowships, and virtual teaching arrangements.
4. Address Critical Skills Gaps in Emerging STEM Fields	Improved institutional capacity in high-demand disciplines such as Artificial Intelligence, Data Science, Robotics, Cybersecurity, Biotechnology, Renewable Energy, Semiconductor Technologies, Quantum Computing, Internet of Things (IoT), and Advanced Manufacturing.
5. Promote Gender Equity and Inclusive Recruitment	Increased recruitment and retention of women, persons with disabilities, and underrepresented groups in STEM academic positions, contributing to a more inclusive higher education system.
6. Enhance Digital Competence of STEM Academics	Newly recruited academics possess strong digital teaching, research, and innovation competencies, enabling effective ICT-enabled teaching, online learning, virtual laboratories, and digital research collaboration.
7. Improve Institutional Competitiveness and Research Excellence	Higher-quality faculty leading to increased research publications, patents, innovation outputs, external research grants, and improved global university rankings.
8. Strengthen University–Industry–Government Collaboration	Increased recruitment of academics with industry experience and stronger partnerships between higher education institutions, research institutes,

	government agencies, and industry to improve curriculum relevance and innovation.
9. Develop Sustainable Talent Pipeline and Career Progression Systems	Institutionalized succession planning, postdoctoral pathways, mentorship programmes, early-career faculty development, and leadership development ensuring long-term sustainability of the STEM workforce.
10. Improve Staff Retention through Enabling Work Environment	Enhanced retention of qualified STEM academics through competitive remuneration, research funding, modern laboratories, career advancement opportunities, housing support, international mobility, and recognition programmes.

Strategic Interventions

The strategic activities focus on establishing transparent and merit-based recruitment processes, strengthening national STEM workforce planning, attracting Nigerian diaspora and international scholars, expanding recruitment in frontier STEM disciplines, promoting inclusive and gender-responsive hiring, and enhancing digital competencies among academic staff. In addition, they seek to strengthen university–industry collaboration, modernize human resource management through digital systems, develop future academic leaders, and create enabling conditions that improve staff retention and research excellence. The strategic activities and programmes (Table 4.17) are designed to achieve the goals of recruiting, developing, and retaining a globally competitive STEM academic workforce capable of supporting Nigeria's ICT-enabled STEM Transformation Strategy.

Table 4.17: Strategic Activities, Programmes and Key Performance Indicators (KPIs) for the Recruitment of Qualified STEM Academics Component

Strategic Goal	Strategic Activities	Programmes/Initiatives	Key Performance Indicators (KPIs)
1. Strengthen the National STEM Academic Workforce	Conduct national STEM workforce planning; recruit additional STEM faculty based on institutional needs.	National STEM Academic Recruitment Programme (NSARP). Annual Faculty Recruitment Drive	Number of STEM academics recruited annually. STEM staff-to-student ratio. Percentage of vacant STEM positions filled
2. Establish Transparent and Merit-Based Recruitment Systems	Develop national recruitment guidelines; digitize recruitment processes; standardize competency-based selection.	National STEM Recruitment Portal. Competency-Based Recruitment Framework	Percentage of institutions using standardized recruitment procedures. Recruitment cycle completion time. Percentage of appointments made through digital platforms
3. Attract Nigerian Diaspora and International STEM Talent	Introduce incentives for diaspora engagement; establish visiting professorships and joint appointments.	STEM Diaspora Return Fellowship. Visiting Professorship Scheme, Global STEM Talent Initiative	Number of diaspora academics recruited Number of international faculty appointments Number of visiting professors engaged annually
4. Recruit Experts in Emerging STEM Fields	Prioritize hiring in frontier technologies and interdisciplinary disciplines.	Frontier STEM Faculty Expansion Programme Emerging Technology Chairs Initiative	Number of academics recruited in AI, Robotics, Cybersecurity. Biotechnology. Renewable Energy, Data Science, etc.

			Number of new programmes supported by recruited experts
5. Promote Gender Equity and Inclusive Recruitment	Implement affirmative recruitment policies; encourage applications from women and underrepresented groups.	Women in STEM Faculty Initiative. Inclusive Academic Recruitment Programme	Percentage of female STEM academics recruited Percentage of institutions implementing gender-responsive recruitment policies. Representation of underserved regions and persons with disabilities
6. Enhance Digital Competence of New Recruits	Require digital competency certification; provide induction on digital teaching and research tools.	Digital Faculty Readiness Programme. ICT Pedagogy Certification Programme	Percentage of newly recruited academics certified in digital pedagogy. Number of faculty trained in AI-enabled teaching and virtual laboratories
7. Improve Faculty Retention and Career Development	Strengthen incentives, mentoring, promotion pathways, and research support.	Early Career STEM Academic Programme National STEM Mentorship Scheme. Academic Career Development Programme	Faculty retention rate Promotion rate of STEM academics. Staff satisfaction index . Number of mentoring relationships established
8. Strengthen Research Capacity through Recruitment	Recruit research-active academics with proven publication and grant records; provide start-up research grants.	Research Excellence Recruitment Initiative. Young Investigator Programme	Number of recruited academics with PhDs and postdoctoral experience. Publications per academic Research grants secured Patents and innovations generated
9. Strengthen University–Industry Collaboration	Recruit academics with industry experience; establish industry-linked appointments and adjunct positions.	Industry Professor Programme. Innovation Fellows Scheme • Professor of Practice Initiative	Number of industry experts recruited. Number of joint research projects Industry-funded research income. Number of technology commercialization projects
10. Build Sustainable Academic Leadership Pipeline	Recruit postdoctoral fellows and early-career academics; implement succession planning.	National Postdoctoral Fellowship Programme Future STEM Leaders Initiative.Academic Leadership Development Programme	Number of postdoctoral fellows recruited. Number of leadership training participants. Percentage of leadership positions filled internally
11. Modernize Human Resource Management	Develop integrated academic workforce information systems and workforce analytics.	National Academic Workforce Management System. STEM Human Capital Observatory	National STEM faculty database established. Percentage of institutions using digital HR systems. Annual workforce reports published
12. Strengthen International Collaboration for Talent Recruitment	Develop bilateral agreements with international universities and research institutions for faculty exchange and recruitment.	Global Faculty Mobility Programme. International Academic Partnership Scheme	Number of international partnerships established Number of faculty exchange programmes Number of collaborative appointments

Responsibilities

By clearly assigning responsibilities, the matrix (Table 4.18) promotes effective coordination, strengthens accountability, minimizes duplication of efforts, and ensures that all stakeholders work collaboratively to recruit, develop, and retain a high-quality STEM academic workforce capable of advancing excellence in teaching, research, innovation, and national development.

Table 4.18: Responsibility Matrix for the Recruitment of Qualified STEM Academics Component

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level
Develop a National STEM Academic Workforce Plan and recruitment policy framework	Federal Ministry of Education (FME); National Universities Commission (NUC)	National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); Office of the Head of the Civil Service of the Federation; Federal Ministry of Labour and Employment	National
Conduct periodic STEM academic workforce needs assessments across tertiary institutions	NUC; NBTE; NCCE	Federal and State Ministries of Education; Tertiary Institutions; National Bureau of Statistics (NBS)	National, State, Institutional
Establish a National Digital STEM Academic Recruitment Portal	FME; NUC	National Information Technology Development Agency (NITDA); Galaxy Backbone; TETFund; NBTE; NCCE	National
Standardize competency-based and merit-driven recruitment guidelines for STEM academics	NUC; NBTE; NCCE	Federal Civil Service Commission; State Education Commissions; Professional Regulatory Bodies	National, Institutional
Recruit qualified STEM academics to address staffing gaps	Governing Councils and Management of Tertiary Institutions	FME; State Ministries of Education; NUC; NBTE; NCCE; TETFund	Institutional
Recruit specialists in emerging STEM disciplines (AI, Robotics, Cybersecurity, Biotechnology, Data Science, Renewable Energy, etc.)	Tertiary Institutions	NUC; NBTE; NCCE; Industry Partners; National Research Institutes	Institutional
Implement a National STEM Diaspora Recruitment and Return Programme	FME; Nigerians in Diaspora Commission (NiDCOM)	Ministry of Foreign Affairs; NUC; TETFund; Tertiary Institutions; International Development Partners	National
Establish Visiting Professorship and Global Faculty Exchange Schemes	NUC; TETFund	Universities; International Universities; Research Institutes; Development Partners	National, Institutional
Promote gender-responsive and inclusive STEM recruitment policies	FME; Federal Ministry of Women Affairs	NUC; NBTE; NCCE; State Governments; Gender Advocacy Organizations	National, State, Institutional
Introduce incentives to attract and retain outstanding STEM academics	FME; National Salaries, Incomes and Wages Commission	Federal Ministry of Finance; Budget Office; TETFund; Governing Councils	National, Institutional
Establish induction and digital pedagogy training	NUC; NBTE; NCCE	TETFund; National Open University of Nigeria (NOUN); Digital Learning Centres	National, Institutional

for newly recruited academics			
Implement mentorship and early-career academic development programmes	Tertiary Institutions	NUC; TETFund; Learned Societies; Senior Academics	Institutional
Recruit postdoctoral fellows and early-career researchers into academia	TETFund; NUC	Universities; Research Institutes; International Funding Agencies	National, Institutional
Strengthen university–industry recruitment pathways and Professor of Practice schemes	NUC; NBTE	Manufacturers Association of Nigeria (MAN); Nigerian Economic Summit Group (NESG); Industry Associations; Private Sector	National, Institutional
Develop integrated STEM Academic Human Resource Information System (HRIS)	FME; NUC	NITDA; Galaxy Backbone; NBTE; NCCE; Tertiary Institutions	National
Establish a National STEM Academic Database and Talent Observatory	NUC	NBS; TETFund; NBTE; NCCE; FME	National
Monitor compliance with national recruitment standards and staffing benchmarks	NUC; NBTE; NCCE	TETFund; Institutional Governing Councils; Accreditation Panels	National, Institutional
Support continuous professional development for recruited STEM academics	TETFund	NUC; NBTE; NCCE; Professional Bodies; International Partners	National, Institutional
Strengthen academic leadership and succession planning programmes	Tertiary Institution Governing Councils	NUC; Committee of Vice-Chancellors; Committee of Rectors; Colleges of Education Leadership	Institutional
Monitor, evaluate, and report implementation of the STEM academic recruitment strategy	FME	NUC; NBTE; NCCE; TETFund; National Planning Commission; Development Partners	National

Key Performance Indicators

The Key Performance Indicators (KPIs) for the **Recruitment of Qualified STEM Academics** component presented in Table 4.19 provides a results-based framework for monitoring progress, evaluating performance, and measuring the impact of interventions under Nigeria's ICT-enabled STEM Transformation Strategy. The indicators assess improvements in the recruitment, quality, diversity, digital competencies, and retention of STEM academics across universities, polytechnics, and colleges of education. They also measure institutional capacity to attract global talent, strengthen research excellence, and address workforce shortages in emerging STEM disciplines. The KPI framework is structured around four implementation milestones: **Baseline (2026)**, **Short-term (2027–2029)**, **Medium-term (2030–2032)**, and **Long-term (2033–2035)**. These phased targets provide measurable benchmarks that will support evidence-based decision-making, accountability, and continuous improvement throughout implementation.

Table 4.19: Key Performance Indicators and Targets for the for the Recruitment of Qualified STEM Academics

Key Performance Indicator (KPI)	Baseline (2026)	Short-Term Target (2027–2029)	Medium-Term Target (2030–2032)	Long-Term Target (2033–2035)
STEM academic vacancies filled annually	Less than 50% of vacancies filled	70% of vacancies filled	90% of vacancies filled	100% of priority STEM vacancies filled
Number of qualified STEM academics recruited	Estimated 0 (new strategy baseline)	5,000 additional academics recruited	12,000 cumulative recruits	20,000 cumulative recruits
Student-to-STEM academic ratio	Approximately 45:1	Reduced to 35:1	Reduced to 25:1	Reduced to 20:1 or better
Percentage of STEM academics with PhD qualifications	Approximately 65%	75%	85%	95%
Recruitment in emerging STEM disciplines	Limited and uneven	Experts recruited in 50% of institutions	Experts available in 80% of institutions	Experts available in all tertiary institutions
Institutions implementing competency-based recruitment	Less than 20%	60%	90%	100%
Institutions using digital recruitment platforms	Less than 15%	70%	95%	100%
Average recruitment cycle (advertisement to appointment)	9–12 months	Reduced to 6 months	Reduced to 4 months	Reduced to 3 months
Nigerian diaspora STEM academics recruited	Fewer than 100 nationwide	500 recruited	1,500 recruited	3,000 recruited
International visiting professors engaged annually	Limited (<50)	200	500	1,000
Female representation among newly recruited STEM academics	Approximately 25%	35%	40%	At least 45%
Representation of underserved regions and vulnerable groups	Low	Inclusive recruitment policy adopted in 50% of institutions	80% of institutions implementing inclusive recruitment	100% institutional compliance
Newly recruited academics certified in digital pedagogy	Less than 10%	60%	90%	100%
Institutions implementing structured induction and mentoring programmes	Approximately 20%	60%	90%	100%
Five-year retention rate of recruited STEM academics	Approximately 60%	75%	85%	Above 90%
Research-active recruits (with publications and grant experience)	Limited	40% of recruits	60% of recruits	80% of recruits

Annual peer-reviewed publications by newly recruited academics	Baseline to be established	25% increase	60% increase	100% increase
External research grants secured by recruited academics	Low	30% increase	70% increase	150% increase
Patents, prototypes, and technology innovations generated	Limited	100 outputs	500 outputs	1,000+ outputs
Industry-linked academic appointments	Very limited	200 appointments	600 appointments	1,200 appointments
Universities with STEM workforce succession plans	Less than 10%	50%	80%	100%
National STEM Academic Workforce Database operational	Not available	Database established	Annual workforce analytics published	Fully integrated national workforce intelligence system
Institutions complying with national recruitment standards	Less than 20%	60%	90%	100%
Employer satisfaction with quality of STEM graduates	Moderate	20% improvement	40% improvement	60% improvement
Nigerian universities meeting international STEM staffing benchmarks	Few institutions	20 institutions	50 institutions	All eligible public universities meeting benchmarks

Performance Measurement Approach

The implementation of these KPIs shall enable the Federal Ministry of Education and relevant regulatory agencies to:

1. Monitor national STEM workforce growth and institutional staffing adequacy.
2. Evaluate the effectiveness, transparency, and efficiency of recruitment systems.
3. Track progress in attracting diaspora and international STEM talent.
4. Measure improvements in gender equity, inclusiveness, and regional balance.
5. Assess institutional readiness in emerging and frontier STEM disciplines.
6. Evaluate improvements in research productivity, innovation, and industry engagement.
7. Monitor faculty retention and career progression.
8. Support evidence-based policy adjustments and resource allocation.
9. Benchmark Nigeria's progress against regional and global higher education standards.

Timelines

The implementation timeline for the **Recruitment of Qualified STEM Academics** component provides a phased roadmap for achieving the strategic goals of Nigeria's ICT-enabled STEM Transformation Strategy. The phased approach enables the Federal Ministry of Education, regulatory agencies, and tertiary institutions to progressively strengthen STEM workforce planning, modernize recruitment systems, attract world-class talent, enhance faculty quality,

and build sustainable institutional capacity. The timeline is organized into **Short-Term (2027–2029)**, **Medium-Term (2030–2032)**, and **Long-Term (2033–2035)** phases, allowing for systematic implementation, continuous monitoring, and adaptive improvements.

Table 4.20: Implementation phase and key milestones

Phase	Key Milestones
Phase I: Foundation and System Development (2027–2029)	Develop national recruitment policies; establish digital recruitment systems; conduct workforce planning; begin priority recruitment; launch diaspora engagement and digital competency programmes.
Phase II: Expansion and Capacity Building (2030–2032)	Scale recruitment nationwide; strengthen research capacity; expand recruitment in frontier STEM disciplines; institutionalize mentorship, leadership development, and industry partnerships; improve gender equity and inclusion.
Phase III: Consolidation and Global Competitiveness (2033–2035)	Achieve optimal staffing levels; institutionalize sustainable recruitment and retention systems; strengthen international competitiveness; establish Nigeria as a regional leader in STEM education, research, innovation, and digital transformation.

Expected Outcomes

Table 4.21: Expected outcomes for each implementation phase

Implementation Phase	Expected Outcomes
Short-Term (2027–2029)	Transparent recruitment systems established; increased recruitment of qualified STEM academics; digital recruitment platforms operational; diaspora engagement programmes initiated; improved institutional staffing in priority disciplines.
Medium-Term (2030–2032)	Significant reduction in faculty shortages; stronger research capacity; improved gender balance; enhanced digital competencies; expanded university–industry collaboration; increased recruitment in emerging STEM fields.
Long-Term (2033–2035)	Sustainable, globally competitive STEM academic workforce; high faculty retention; internationally competitive research and innovation performance; equitable staffing across institutions; strong contribution to Nigeria's digital economy and knowledge-based development.

4.5 Continuous Professional Development of Innovative Curricular, Pedagogical and Assessment Practices

Introduction

Continuous Professional Development (CPD) is a critical pillar of Nigeria's STEM Transformation Agenda, ensuring that academic staff continuously acquire the knowledge, competencies, and digital skills required to deliver high-quality, future-oriented STEM education. As science, technology, engineering, and mathematics continue to evolve rapidly, educators must regularly update their instructional approaches to align with emerging technologies, interdisciplinary knowledge, industry needs, and global best practices. CPD enables lecturers and instructors to move beyond traditional teacher-centred approaches toward learner-centred, inquiry-based, project-based, experiential, competency-based, and digitally

enabled teaching that prepares graduates for the Fourth Industrial Revolution and the emerging knowledge economy.[82]

Innovative curricular practices involve equipping educators with the capacity to design competency-based, interdisciplinary, flexible, and industry-responsive STEM curricula that integrate entrepreneurship, sustainability, artificial intelligence, data science, digital literacy, and problem-solving skills. At the same time, innovative pedagogical practices emphasize active learning approaches such as project-based learning, problem-based learning, design thinking, flipped classrooms, virtual laboratories, simulation-based learning, collaborative learning, and the effective use of digital technologies to personalize instruction and improve student engagement. These approaches foster creativity, innovation, critical thinking, and lifelong learning competencies that are essential for national development.

Equally important is the modernization of assessment practices. Traditional examinations alone are insufficient for evaluating twenty-first-century competencies. Continuous professional development should therefore strengthen educators' capacity to design authentic, competency-based assessments that evaluate practical skills, creativity, teamwork, digital competencies, innovation, and real-world problem-solving. Modern assessment methods include portfolios, capstone projects, industry-based assessments, digital badges, peer assessment, formative assessment, and e-portfolios provide richer evidence of student learning and better align international quality assurance standards.

Nigeria seeks to strengthen CPD towards significantly improving teaching quality, graduate employability, research productivity, innovation capacity, institutional competitiveness, and the overall quality of STEM education in higher education. It will also support the successful implementation of other components of the STEM Transformation Agenda, including curriculum modernization, digital transformation, industry partnerships, research commercialization, talent development, quality assurance. By institutionalizing continuous professional learning across universities, polytechnics, colleges of education, and other tertiary institutions, Nigeria can build a highly competent STEM workforce capable of driving industrialization, technological advancement, and sustainable national development

Vison

“To build a culture of excellence in STEM teaching through continuous professional learning, innovation, and digital transformation.”

Mission

“To institutionalize a sustainable system of continuous professional development that empowers STEM educators with contemporary curricular design capabilities, innovative pedagogical approaches, authentic assessment practices, digital competencies, educational research skills, and industry-relevant expertise to enhance teaching excellence, student success, innovation, and lifelong learning across Nigeria's higher education system”.

Strategic Goals

[82] Organisation for Economic Co-operation and Development. (2023). OECD Digital Education Outlook 2023: Towards an Effective Digital Education Ecosystem. OECD Publishing, Paris. DOI: 10.1787/c74f03de-en.

In achieving the vision and mission of the **Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices** component of Nigeria's ICT-enabled STEM Transformation Agenda, the strategic goals (Table 4.22) are focused on building educator capacity, institutionalizing lifelong professional learning, integrating digital technologies, strengthening teaching quality, and fostering innovation in STEM education.

Table 4.22: Strategic goals and their desired outcomes for Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices component of Nigeria's ICT-enabled STEM Transformation Agenda

Strategic Goal	Desired Outcomes/Expectations
1. Institutionalize a sustainable Continuous Professional Development (CPD) framework for STEM educators across all tertiary institutions.	National CPD policy and standards adopted. Structured and mandatory CPD programmes implemented across universities, polytechnics, and colleges of education. Increased participation of academic staff in accredited professional development programmes. CPD integrated into academic promotion and performance evaluation systems.
2. Strengthen educators' capacity to design and deliver innovative, competency-based and industry-responsive STEM curricula.	Lecturers proficient in competency-based curriculum design. Modernized STEM curricula aligned with emerging technologies and labour market needs. Increased interdisciplinary and entrepreneurship-focused learning experiences. Stronger alignment between academic programmes and national development priorities.
3. Enhance the adoption of innovative, learner-centred and technology-enabled pedagogical practices.	Increased use of active learning, problem-based learning, project-based learning, flipped classrooms, virtual laboratories, simulations, and blended learning. Improved student engagement and learning outcomes. Greater integration of Artificial Intelligence, digital platforms, and educational technologies into teaching.
4. Modernize assessment systems to promote competency-based, authentic and continuous assessment.	Diversified assessment methods including portfolios, capstone projects, practical demonstrations, digital assessments, peer assessment, and workplace-based evaluation. Improved measurement of higher-order thinking, innovation, creativity, teamwork, and problem-solving skills. Reduced reliance on traditional examinations.
5. Develop digital competencies and educational technology skills among STEM educators.	Increased digital literacy among academic staff. Effective use of Learning Management Systems (LMS), virtual laboratories, learning analytics, AI-enabled teaching tools, and open educational resources. Improved quality of online and blended STEM education.
6. Promote evidence-based teaching, scholarship of teaching and learning (SoTL), and educational research.	Increased educational research publications in STEM teaching and learning. Greater use of learning analytics and classroom research to improve instructional practices. Adoption of evidence-informed teaching across institutions. Strong communities of practice among educators.
7. Strengthen partnerships between academia, industry, professional bodies, and international institutions for professional learning.	Increased industry-led training, internships, sabbaticals, and co-teaching opportunities. Enhanced collaboration with professional societies and international universities. Greater exposure to global best practices in STEM education. Improved graduate employability through industry-informed teaching.
8. Establish a national ecosystem for mentoring, peer learning, coaching, and professional collaboration.	National STEM educator mentoring programme established. Communities of practice operational across disciplines and institutions. Improved teaching quality through peer observation and collaborative learning. Enhanced leadership capacity among academic staff.
9. Promote inclusive, equitable and gender-responsive teaching practices.	Improved capacity of educators to support diverse learners. Greater participation and success of women and underrepresented groups in STEM. Inclusive curricula and pedagogical practices adopted across institutions. Reduced achievement gaps among student populations.
10. Strengthen quality assurance and recognition systems for teaching excellence.	National standards for teaching excellence implemented. Regular teaching quality evaluations conducted. Professional certifications and

	micro-credentials recognized nationally. Awards and incentives motivate innovation and continuous improvement in teaching.

Strategic Interventions

The proposed interventions Table 4.23 translate the strategic goals into practical, measurable actions that can be implemented at national, state, and institutional levels through collaboration among government agencies, higher education institutions, professional bodies, industry partners, and development partners. To ensure effective implementation, accountability, and continuous improvement, each programme is accompanied by clearly defined Key Performance Indicators (KPIs) that will enable systematic monitoring of progress, evaluation of outcomes, and evidence-based decision-making. Collectively, these strategic interventions will contribute to developing a highly competent, innovative, digitally proficient, and globally competitive STEM academic workforce capable of delivering high-quality education that supports Nigeria's scientific advancement, industrialization, and sustainable socio-economic development.

Table 4.23: Strategic Interventions, Programmes, and Key Performance Indicators (KPIs) for the Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices component of Nigeria's ICT-enabled STEM Transformation Agenda

Strategic Intervention	Programme(s)	Key Performance Indicators (KPIs)
1. Develop and institutionalize a National STEM CPD Framework	National STEM CPD Policy and Standards Programme Institutional CPD Framework Development Initiative	National CPD framework approved Percentage of institutions adopting CPD policies Number of institutions with annual CPD plans Percentage of STEM academic staff participating in annual CPD
2. Strengthen competency-based curriculum design capacity	Curriculum Innovation Academy. Curriculum Design Certification Programme Curriculum Review Workshops	Number of academics trained in competency-based curriculum design Number of STEM programmes reviewed annually Percentage of curricula aligned with industry competency standards Employer satisfaction with curriculum relevance
3. Promote innovative and learner-centred pedagogies	STEM Teaching Excellence Programme Active Learning and Problem-Based Learning Initiative Project-Based Learning Implementation Programme	Percentage of lecturers adopting active learning strategies. Number of courses redesigned using learner-centred approaches. Student engagement and satisfaction scores. Improvement in student learning outcomes
4. Build educators' digital teaching competencies	Digital Pedagogy Certification Programme. Educational Technology Capacity Building Initiative AI in STEM Teaching Programme	Percentage of lecturers certified in digital pedagogy Number of digital teaching tools adopted. Percentage of courses delivered through blended learning Utilization rate of Learning Management Systems (LMS)
5. Modernize assessment practices	Competency-Based Assessment Programme. Digital Assessment Initiative Authentic Assessment and E-Portfolio Programme	Percentage of courses using authentic assessments. Number of lecturers trained in competency-based assessment Percentage reduction in examination-only assessment Student competency attainment rates
6. Establish STEM Teaching Innovation Centres	National STEM Teaching Innovation Centres. Institutional Teaching and Learning Excellence centres or Hubs	Number of centres established and operational. Number of educators supported annually. Number of innovative teaching projects developed. Satisfaction ratings of centre users
7. Promote scholarship of teaching and learning (SoTL)	STEM Education Research Grant Scheme• Teaching	Number of SoTL research projects funded Number of publications on STEM education. Number of conference presentations on

	Innovation Research Programme• Educational Research Fellowship	teaching innovation• Adoption of research findings into teaching practice
8. Strengthen mentoring, peer learning, and professional communities	National STEM Mentorship Programme. Communities of Practice Network. Peer Observation and Coaching Initiative	Number of mentor–mentee pairs established. Number of active communities of practice. Number of peer observation sessions conducted annually Improvement in teaching performance ratings
9. Strengthen academia–industry collaboration for educator development	Industry Attachment Programme for Academics Industry Co-Teaching Initiative• STEM Industry Fellowship Programme	Number of lecturers participating in industry attachments Number of industry experts engaged in teaching Number of industry-academic collaborative projects Employer satisfaction with graduate competencies
10. Promote inclusive and gender-responsive STEM teaching	Inclusive STEM Education Programme. Gender-Responsive Pedagogy Initiative Universal Design for Learning (UDL) Training	Percentage of educators trained in inclusive teaching Number of institutions implementing inclusive teaching policies Female student retention and completion rates in STEM Student perception of inclusive learning environments
11. Establish a national certification and micro-credentialing system for educators	STEM Educator Professional Certification Programme• Digital Micro-Credential Platform	Number of educators earning certifications. Number of micro-credentials awarded annually. Percentage of certified STEM educators. Recognition of certifications in promotion criteria
12. Strengthen leadership capacity in STEM education	Academic Leadership Development Programme Departmental Leadership Academy• Change Management Programme	Number of academic leaders trained Institutional implementation of teaching innovation strategies. Leadership competency assessment scores. Percentage of institutions with teaching innovation action plans
13. Establish a national digital CPD platform	National STEM Learning Portal Online CPD Academy Open Educational Resources (OER) Platform	Digital CPD platform operational. Number of online courses available Number of registered users• Course completion rates
14. Strengthen monitoring, evaluation, and quality assurance of CPD	National CPD Monitoring Framework Teaching Quality Assessment Programme Institutional Teaching Excellence Audits	Annual institutional CPD reports submitted. Percentage of institutions meeting CPD standards. Teaching quality index improvement• National STEM Teaching Excellence Index
15. Recognize and reward excellence in STEM teaching	National STEM Teaching Excellence Awards• Institutional Innovation Awards• Teaching Innovation Grants	Number of awards presented annually Number of innovation grants awarded Increase in teaching innovation projects Staff motivation and retention indicators

Responsibilities

The successful implementation of the **Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices** component requires strong coordination among federal and state governments, regulatory agencies, tertiary education institutions, industry partners, professional bodies, and development partners. The responsibility matrix in Table 4.24 outlines the lead and supporting institutions responsible for implementing each strategic intervention at the national, state, and institutional levels. This collaborative governance approach promotes accountability, resource mobilization, effective coordination, and sustainable implementation of professional development initiatives across Nigeria's higher education system.

Table 4.24: Responsibility matrix for the implementation of Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices in Nigeria's Higher Education

Strategic Intervention	Lead Institution(s)	Supporting Institutions	Implementation Level (National, State, Institutional)
Develop and institutionalize a National STEM Continuous Professional Development (CPD) Framework	Federal Ministry of Education (FME); National Universities Commission (NUC)	National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); TETFund; State Ministries of Education	National
Develop institutional CPD policies and implementation plans	NUC; NBTE; NCCE	Governing Councils; Vice Chancellors; Rectors; Provosts	Institutional
Strengthen competency-based curriculum design capacity	NUC; NBTE; NCCE	TETFund; Professional Bodies; Industry Partners; Universities	National, Institutional
Promote innovative learner-centred pedagogies	Higher Education Institutions (HEIs)	Centres for Teaching and Learning; Academic Staff Unions; Professional Associations	Institutional
Build digital teaching competencies among STEM educators	TETFund	NUC; NBTE; NCCE; Nigerian Research and Education Network (NgREN); ICT Academies; Technology Companies	National, Institutional
Establish STEM Teaching and Learning Innovation Centres	TETFund	Federal Ministry of Education; HEIs; Development Partners	National, Institutional
Modernize assessment systems and competency-based evaluation	NUC; NBTE; NCCE	HEIs; Quality Assurance Units; Professional Accreditation Bodies	National, Institutional
Promote Scholarship of Teaching and Learning (SoTL) and educational research	TETFund	Universities; Research Institutes; Professional Associations; Development Partners	National, Institutional
Strengthen mentoring, coaching, and Communities of Practice	Higher Education Institutions	Academic Departments; Centres for Teaching Excellence; Professional Societies	Institutional
Implement industry attachment and academic immersion programmes	Industrial Training Fund (ITF); HEIs	Private Sector; Manufacturers Association of Nigeria (MAN); Nigerian Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA); Sector Skills Councils	National, Institutional
Promote inclusive, gender-responsive, and disability-inclusive STEM teaching	Federal Ministry of Education	Federal Ministry of Women Affairs; NUC; NBTE; NCCE; National Commission for Persons with Disabilities; Development Partners	National, State, Institutional
Establish national STEM educator certification and micro-credentialing programmes	NUC	NBTE; NCCE; Teachers Registration Council of Nigeria (TRCN); Professional Bodies; TETFund	National

Develop and operate a National Digital CPD Platform	Federal Ministry of Education	TETFund; NgREN; NUC; NBTE; NCCE; ICT Service Providers	National
Strengthen leadership and change management capacity for STEM education	TETFund	National Institute for Educational Planning and Administration (NIEPA); HEIs; Leadership Development Institutes	National, Institutional
Monitor, evaluate, and assure quality of CPD implementation	NUC; NBTE; NCCE	TETFund; Quality Assurance Agencies; HEIs; Independent Evaluators	National, Institutional
Establish STEM Teaching Excellence Awards and Incentive Scheme	Federal Ministry of Education	TETFund; NUC; NBTE; NCCE; Professional Bodies; Development Partners	National

Key Performance Indicators

A robust Monitoring, Evaluation, Accountability, and Learning (MEAL) framework is essential for assessing the implementation and impact of the Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices component of Nigeria's ICT-enabled STEM Transformation Agenda. The Key Performance Indicators (KPIs) below provide measurable benchmarks for tracking progress from the current baseline through short-term (Years 1–2), medium-term (Years 3–5), and long-term (Years 6–10) implementation phases (Table 4.25). These targets are designed to support evidence-based decision-making, promote accountability, and ensure continuous improvement in teaching quality, curriculum innovation, digital pedagogy, and student learning outcomes across Nigeria's tertiary education institutions.

Table 4.25: The Key Performance Indicators (KPIs) for measurement of targets in the Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices component of Nigeria's ICT-enabled STEM Transformation strategy

Key Performance Indicator (KPI)	Baseline (2026)	Short-Term Target (Years 1–2)	Medium-Term Target (Years 3–5)	Long-Term Target (Years 6–10)
Institutions adopting a formal CPD policy and framework	<20%	50%	85%	100%
STEM academic staff completing at least one accredited CPD programme annually	25%	50%	75%	95%
Academic staff certified in innovative pedagogy and digital teaching	10%	40%	70%	90%
STEM programmes reviewed using competency-based curriculum approaches	15%	40%	75%	100%
Courses redesigned using learner-centred pedagogies	20%	45%	75%	95%
STEM courses delivered through blended or	30%	50%	80%	100%

technology-enhanced learning				
Academic staff trained in Artificial Intelligence and emerging educational technologies	5%	30%	65%	90%
Institutions with functional STEM Teaching and Learning Innovation Centres	5%	30%	70%	100%
Academic staff trained in competency-based and authentic assessment methods	15%	50%	80%	100%
Courses using authentic assessment (projects, portfolios, capstones, simulations, etc.)	15%	40%	70%	90%
Institutions implementing Learning Management Systems (LMS) across STEM programmes	45%	70%	90%	100%
Academic staff participating in peer mentoring and professional learning communities	20%	50%	80%	95%
STEM educators participating in industry attachment or professional immersion programmes	5%	20%	50%	80%
Institutions implementing annual teaching quality reviews	30%	60%	90%	100%
STEM educators receiving national teaching certification or micro-credentials	5%	25%	60%	90%
Scholarship of Teaching and Learning (SoTL) research projects funded annually	20 projects	80 projects	200 projects	400 projects
Peer-reviewed publications on STEM education and innovative teaching	100 publications/year	250/year	500/year	1,000/year
National Digital CPD Platform operational and actively used	Not available	Platform launched with 30,000 users	100,000 active users	250,000 active users
Student satisfaction with teaching quality	60%	70%	80%	90%
Graduate satisfaction with teaching and learning experience	55%	70%	80%	90%
Employer satisfaction with graduates' workplace competencies	50%	65%	80%	90%

Female STEM academic staff participating in CPD programmes	30%	45%	60%	Gender parity (≈50% participation with equal access)
Educators trained in inclusive and gender-responsive pedagogy	10%	40%	75%	100%
Institutions implementing inclusive teaching and Universal Design for Learning (UDL) practices	15%	40%	75%	100%
Institutions achieving national teaching excellence accreditation standards	10%	35%	70%	100%
National annual STEM Teaching Excellence Awards presented	None	Annual awards established	Awards institutionalized across all geopolitical zones	Internationally recognized national awards programme

Timelines

The implementation of the **Continuous Professional Development (CPD) of Innovative Curricular, Pedagogical and Assessment Practices** components shall be undertaken in three sequential phases over a **10-year period**. Each phase builds upon the achievements of the previous one, beginning with policy development and institutional readiness, followed by nationwide implementation and scaling, and culminating in institutionalization, quality enhancement, and sustainability. This phased approach minimizes implementation risks while ensuring that reforms are effectively embedded across Nigeria's tertiary education system.

Table 4.26: Implementation Timeline Matrix

Implementation Phase	Timeline	Key Activities
Phase I: Foundation and Capacity Building	**2027 - 2028**	Develop and approve the National STEM CPD Policy and Framework. Establish National CPD Steering Committee and governance structure. Conduct national competency and training needs assessment for STEM educators. Develop institutional CPD policies and annual implementation plans. Design national CPD curriculum and competency standards. Launch the National Digital CPD Platform. Develop CPD modules on curriculum innovation, learner-centred pedagogy, digital teaching, AI, and competency-based assessment. Pilot STEM Teaching and Learning Innovation Centres. Train master trainers and institutional CPD coordinators. Introduce STEM educator certification and micro-credential framework. Establish monitoring, evaluation, and reporting systems. Launch National STEM Teaching Excellence Awards.
Phase II: Implementation, Expansion and Integration	**2029-2031**	Roll out mandatory CPD programmes across all higher institutions. Scale up Teaching and Learning Innovation Centres nationwide. Implement competency-based curriculum design workshops. Expand digital pedagogy, AI-enabled teaching, virtual laboratories, and blended learning training. Institutionalize authentic and competency-based assessment practices. Establish Communities of Practice, mentoring, and peer-learning networks. Implement Scholarship of Teaching and Learning (SoTL) research grants. Strengthen industry attachment, academic exchange, and international collaboration programmes. Expand educator

		certification and micro-credentialing. Conduct annual teaching quality reviews and institutional CPD audits. Undertake mid-term evaluation and refine implementation strategies.
Phase III: Institutionalization, Excellence and Sustainability	**2032-2036**	Fully institutionalize CPD within promotion, accreditation, and quality assurance systems. Ensure all STEM educators participate in annual accredited CPD programmes. Continuously update CPD content to reflect emerging technologies and global best practices. Integrate AI, learning analytics, immersive technologies, and digital innovation into teaching practice. Strengthen national and international partnerships for educator development. Expand research on STEM teaching and learning innovations. Institutionalize national benchmarking and teaching excellence accreditation. Review and update national CPD policies and standards periodically. Conduct annual impact assessments and disseminate best practices. Undertake final programme evaluation and develop the next-generation CPD strategy for Nigeria's STEM higher education system.

Expected Outputs

Table 4.27: Expected outputs

Phase	Key Outputs
Phase I (Years 1–2)	National CPD policy approved; governance structures established; Digital CPD Platform operational; baseline assessment completed; pilot innovation centres established; initial educator training completed; national certification framework launched.
Phase II (Years 3–5)	Mandatory CPD implemented in most institutions; widespread adoption of innovative curricula, pedagogy, and assessment; expanded teaching innovation centres; active professional learning communities; strong industry partnerships; mid-term evaluation completed.
Phase III (Years 6–10)	CPD fully embedded in institutional systems; nationally recognized teaching excellence framework operational; sustained use of digital and AI-enabled teaching; improved graduate learning outcomes; internationally competitive STEM educators; final impact evaluation completed and future strategy developed.

4.6 Close linkages with the productive sectors

Introduction

Strengthening linkages between universities and the productive sectors is essential for enhancing the relevance, quality, and impact of STEM education. Close collaboration with industry, business, and the broader economy ensures that academic programmes are aligned with workforce needs, technological advancements, and national development priorities.

These linkages provide students — especially female STEM students — with practical exposure, career pathways, and opportunities to apply theoretical knowledge in real-world contexts. They also help institutions remain responsive to emerging skills demands in sectors such as ICT, engineering, healthcare, agriculture, and manufacturing.

As Nigeria pursues an ICT-driven, Industry 4.0-aligned economy, the pace of technological change means that curricula and teaching practice can no longer be developed in isolation from the industries they serve. A deliberate, structured, and sustained partnership between

universities and the productive sector is therefore a core pillar of this strategy — one that closes the gap between what is taught and what the economy needs, while embedding gender equity across every point of engagement.

Vision

"A Nigerian STEM higher education system in which universities and the productive sectors operate as genuine partners co-creating knowledge, talent, and innovation so that every graduate enters the workforce industry-ready, and every industry finds in academia a reliable source of skills, research, and technological solutions".

Mission

"To institutionalise structured, inclusive, and mutually beneficial linkages between universities and industry spanning curriculum design, work-integrated learning, research collaboration, entrepreneurship, and mentorship that improve graduate employability, drive innovation, and advance the equitable participation of women in STEM-driven economic growth."

Strategic Goals, and Expected Outcomes

The following strategic goals translate the vision and mission into actionable interventions for strengthening university–industry linkages:

Table 4.28: Strategic Goals, Interventions and Expected Outcomes for Linkages with the productive Sectors

Strategic Goal	Expected Outcome
Goal 1: Institutionalise Industry Partnerships and Curriculum Co-Design	STEM curricula that are continuously updated, industry-relevant, and responsive to Nigeria's evolving economic and technological priorities.
Goal 2: Expand Structured Work-Integrated Learning	Graduates with strengthened practical competencies, improved employability, and demonstrable workplace readiness at the point of graduation.
Goal 3: Strengthen Industry-Led Teaching and Research Collaboration	A stronger flow of applied knowledge and innovation between academia and industry, and curricula enriched by current professional practice.
Goal 4: Promote Entrepreneurship, Innovation and Start-up Support	An expanding pipeline of graduate-founded, technology-driven enterprises, with visibly increased participation of female innovators.
Goal 5: Build Labour Market Intelligence, Mentorship and Gender-Responsive Engagement	Evidence-based, gender-responsive curriculum review cycles and a measurable increase in safe, supportive industry pathways for female STEM graduates.

Strategic Interventions

The key strategic interventions will require coordinated efforts from the NUC/ government agencies, the industries and educational intuitions as elaborate in the table below.

Table 4.29: Strategic Interventions aligned with goals, programmes and KPIs

Strategic Goal	Strategic Intervention	Programmes	KPIs
Goal 1: Institutionalise Industry Partnerships and Curriculum Co-Design	Establish formal MOUs and co-design frameworks with industry, business, and professional bodies Set up joint curriculum review committees involving industry representatives, NUC, and TETFund Align programme content with current and emerging labour market and technological needs.	National University–Industry Curriculum Alignment Programme. Sector-Specific Curriculum Advisory Councils (ICT, Engineering, Health, Agriculture, Manufacturing)	% of STEM programmes with active, signed industry MOUs. Number of curricula reviewed with documented industry input per year Curriculum review cycle frequency (target: every 2 years)
Goal 2: Expand Structured Work-Integrated Learning	Scale up SIWES, internships, and apprenticeship placements across ICT, engineering, healthcare, agriculture, and manufacturing. Improve quality assurance, supervision, and assessment of industrial training placements. Guarantee equitable placement opportunities for female STEM students, including safe accommodation and transport considerations	Enhanced SIWES Programme University–Industry Apprenticeship Scheme Female Student Placement Safety Initiative	% of eligible students completing SIWES/internship placements annually % female participation in industrial training placements Employer satisfaction rating of placed students (annual survey)
Goal 3: Strengthen Industry-Led Teaching and Research Collaboration	Engage industry professionals as guest lecturers, adjunct faculty, and master-class facilitators Promote joint research, innovation hubs, and technology transfer initiatives between universities and industry Support co-funded applied research addressing real-world productive-sector challenges	Industry Fellows / Adjunct Faculty Scheme Joint University–Industry Innovation Hubs Co-Funded Applied Research Grant Facility	Number of industry-delivered guest lectures/master-classes per year Number of active joint research projects funded Number of technology transfer/licensing agreements signed
Goal 4: Promote Entrepreneurship, Innovation and Start-up Support	Strengthen university incubation and innovation centres with dedicated funding and mentoring Provide targeted seed funding, business development support, and market linkages for student-led ventures Actively encourage and profile female-led STEM start-ups and innovations	University Incubation and Innovation Centres STEM Start-up Seed Fund Female Innovators Showcase	Number of active start-ups incubated per year % of supported start-ups that are female-led Value of seed funding disbursed annually
Goal 5: Build Labour Market Intelligence, Mentorship and Gender-Responsive Engagement	Establish a Labour Market Observatory (LMO) providing continuous employer feedback to inform curriculum review Connect students, particularly female students, with industry mentors for career guidance and professional networking Require industry partners to uphold inclusive, equitable, and safe	Labour Market Observatory (LMO) Industry Mentorship Network Gender-Responsive Workplace Charter for Partner Industries	Number of employer feedback reports informing curriculum review per year Number of students matched with industry mentors, disaggregated by gender % of industry partners signed onto the Gender-

	workplace standards for female interns and employees		Responsive Workplace Charter

Implementation Responsibility

The table below assigns each intervention to a lead institution, identifies supporting institutions, and specifies the level at which implementation is coordinated (institutional or national).

Table 4.30: Implementation Responsibility Matri

Intervention	Lead Institution	Supporting Institutions	Implementation Level
Goal 1: Institutionalise Industry Partnerships and Curriculum Co-Design			
Establish formal MOUs and co-design frameworks with industry, business, and professional bodies	Universities	NUC, TETFund, Industry/Professional Bodies	Institutional
Set up joint curriculum review committees involving industry representatives, NUC, and TETFund	NUC	Universities, TETFund, Industry Associations	National
Align programme content with current and emerging labour market and technological needs	Universities (Faculties/Departments)	NUC, Industry Partners	Institutional
Goal 2: Expand Structured Work-Integrated Learning			
Scale up SIWES, internships, and apprenticeship placements across ICT, engineering, healthcare, agriculture, and manufacturing	Industrial Training Fund (ITF)	Universities, NUC, Employers	National
Improve quality assurance, supervision, and assessment of industrial training placements	Universities (SIWES Units)	ITF, NUC	Institutional
Guarantee equitable placement opportunities for female STEM students, including safe accommodation	Universities (Gender/SIWES Units)	ITF, Industry Partners, Women-in-STEM Networks	Institutional

and transport considerations			
Goal 3: Strengthen Industry-Led Teaching and Research Collaboration			
Engage industry professionals as guest lecturers, adjunct faculty, and master-class facilitators	Universities (Faculties/Departments)	Industry and Professional Bodies	Institutional
Intervention	Lead Istitution	Supporting Institution	Implementation Level
Promote joint research, innovation hubs, and technology transfer initiatives between universities and industry	Universities (Research/Innovation Offices)	NITDA, NASENI, TETFund, Industry Partners	Institutional
Support co-funded applied research addressing real-world productive-sector challenges	TETFund	Universities, Industry, NASENI	National
Goal 4: Promote Entrepreneurship, Innovation and Start-up Support			
Strengthen university incubation and innovation centres with dedicated funding and mentoring	Universities (Incubation/Innovation Centres)	NITDA, TETFund, Bank of Industry	Institutional
Provide targeted seed funding, business development support, and market linkages for student-led ventures	Bank of Industry / NITDA	Universities, TETFund	National
Actively encourage and profile female-led STEM start-ups and innovations	Universities (Incubation Centres)	NITDA, Women-in-STEM Networks	Institutional
Goal 5: Build Labour Market Intelligence, Mentorship and Gender-Responsive Engagement			
Establish a Labour Market Observatory (LMO) providing continuous employer feedback to inform curriculum review	NUC	FME, NBS, Industry Associations	National
Connect students, particularly female students, with industry mentors for career guidance and professional networking	Universities (Career Services)	Industry Partners, Alumni Associations	Institutional
Require industry partners to uphold inclusive, equitable,	FME / NUC	Industry Regulatory Bodies, Universities	National

and safe workplace standards for female interns and employees			

4.7 KPI Targets: Baseline, Short-, Medium- and Long-Term

The table below sets indicative baseline positions and phased targets for each KPI, aligned to the implementation horizons used elsewhere in this strategy: Short-Term (2026–2028), Medium-Term (2029–2031), and Long-Term (2032–2035+). Baseline figures are illustrative pending confirmation through a formal baseline data-collection exercise, and should be validated and updated once verified sector data is available.

Table 4.31: Key Performance Indicators, Baseline, Short-Term, Medium-Term and Long-Term

KPI	Baseline	Short-Term (2026–2028)	Medium-Term (2029–2031)	Long-Term (2032–2035+)
Goal 1: Institutionalise Industry Partnerships and Curriculum Co-Design				
% of STEM programmes with active, signed industry MOUs	< 20%	40%	70%	90%+
Number of curricula reviewed with documented industry input per year	< 10 / year	30 / year	60 / year	100+ / year (full coverage)
Curriculum review cycle frequency	Ad hoc, no fixed cycle	Every 3 years	Every 2 years	Every 2 years, institutionalised nationwide
Goal 2: Expand Structured Work-Integrated Learning				
% of eligible students completing SIWES / internship placements annually	~ 60%	75%	90%	95%+
% female participation in industrial training placements	~ 30%	40%	45%	50% (gender parity)
Employer satisfaction rating of placed students (annual survey)	Not systematically measured	Baseline survey established; 60%	75%	85%+
Goal 3: Strengthen Industry-Led Teaching and Research Collaboration				
Number of industry-delivered guest lectures / master-classes per year	< 50 nationally	150 / year	300 / year	500+ / year
Number of active joint research projects funded	< 20	50	100	200+
Number of technology transfer / licensing agreements signed	< 5 / year	15 / year	30 / year	50+ / year
Goal 4: Promote Entrepreneurship, Innovation and Start-up Support				
Number of active start-ups incubated per year	< 100 nationally	300	600	1,000+
% of supported start-ups that are female-led	~ 15%	25%	35%	40%+
Value of seed funding disbursed annually	< ₦500 million	₦2 billion	₦5 billion	₦10 billion+
Goal 5: Build Labour Market Intelligence, Mentorship and Gender-Responsive Engagement				
Number of employer feedback reports informing curriculum review per year	0 (LMO not yet established)	LMO established; 1 national report / year	Annual report with sectoral breakdowns	Real-time LMO dashboard, continuous feedback
Number of students matched with industry mentors, disaggregated by gender	< 1,000 / year	5,000 / year (40% female)	15,000 / year (45% female)	30,000+ / year (50% female)

% of industry partners signed onto the Gender-Responsive Workplace Charter	0%	20%	50%	80%+

5.6.9 Implementation Timeline

Table 4.32: Implementation Timeline within Phases

Phase	Goals	Key Activities/Focus	Expected Milestones
Phase 1: 2026–2028 — Foundation and Establishment	Goal 1: Industry Partnerships and Curriculum Co-Design	Sign initial MOUs with priority industry partners; establish joint curriculum review committees with NUC; pilot co-designed curricula in selected programmes	40% of STEM programmes with active MOUs; review cycle set at every 3 years
	Goal 2: Work-Integrated Learning	Strengthen SIWES coordination with ITF; issue QA guidelines for placements; roll out safety protocols for female students	75% completion rate for eligible students; 40% female participation
	Goal 3: Industry-Led Teaching and Research	Recruit industry professionals as adjunct faculty; launch pilot innovation hubs; open TETFund co-funded research call	150 guest lectures/year; 50 active joint research projects
	Goal 4: Entrepreneurship and Start-up Support	Establish/strengthen incubation centres; launch seed fund with Bank of Industry/NITDA; identify and profile early female-led start-ups	300 start-ups incubated/year; 25% female-led; ₦2 billion disbursed
	Goal 5: Labour Market Intelligence and Mentorship	Establish the Labour Market Observatory (LMO); pilot mentorship matching; introduce the Gender-Responsive Workplace Charter	LMO established with first national report; 5,000 mentees matched; 20% charter sign-on
Phase 2: 2029–2031 — Scale-Up and Consolidation	Goal 1: Industry Partnerships and Curriculum Co-Design	Expand MOUs across all STEM faculties; institutionalise the 2-year curriculum review cycle nationwide	70% MOU coverage; 60 curricula reviewed with industry input per year
	Goal 2: Work-Integrated Learning	Roll out a national SIWES quality-assurance framework; scale female placement-safety programmes across institutions	90% completion rate; 45% female participation; 75% employer satisfaction
	Goal 3: Industry-Led Teaching and Research	Expand innovation hubs to all universities; scale technology transfer and licensing activity	300 guest lecturers/year; 100 joint research projects; 30 technology transfer agreements/year
	Goal 4: Entrepreneurship and Start-up Support	Scale incubation centres nationally; increase seed-fund allocations and market-linkage support	600 start-ups incubated/year; 35% female-led; ₦5 billion disbursed
	Goal 5: Labour Market Intelligence and Mentorship	LMO begins producing annual reports with sectoral breakdowns; scale mentorship network; expand Charter uptake among industry partners	15,000 mentees matched (45% female); 50% of industry partners signed onto the Charter

Phase 3: 2032–2035+ — Institutionalisation and Sustainability	Goal 1: Industry Partnerships and Curriculum Co-Design	Achieve nationwide institutionalisation of industry partnerships; embed continuous curriculum improvement as standard practice	90%+ MOU coverage; full annual curriculum review coverage
	Goal 2: Work-Integrated Learning	Fully embed SIWES/apprenticeship pathways with digital tracking and monitoring	90%+ MOU coverage; full annual curriculum review coverage
	Goal 3: Industry-Led Teaching and Research	Mature a self-sustaining university–industry innovation ecosystem	90%+ MOU coverage; full annual curriculum review coverage
	Goal 4: Entrepreneurship and Start-up Support	Sustain a robust, self-financing entrepreneurship ecosystem across all universities	90%+ MOU coverage; full annual curriculum review coverage
	Goal 5: Labour Market Intelligence and Mentorship	Operationalise a real-time LMO dashboard; fully mainstream mentorship and the Gender-Responsive Workplace Charter	90%+ MOU coverage; full annual curriculum review coverage

Expected Outcomes

Building on the phased actions and milestones above, the following outcomes are expected to be realised from strengthened university–industry linkages at each stage of implementation:

Phase 1: 2026–2028 — Foundation and Establishment

1. Foundational university–industry partnerships and MOUs are in place, giving students their first structured access to industry-aligned curricula and practical exposure
2. SIWES, internship, and apprenticeship pathways are better coordinated and quality-assured, with safety protocols established for female students
3. Early industry-led teaching, pilot innovation hubs, and co-funded research begin enriching classroom learning with real-world practice
4. Incubation centres and seed-fund mechanisms are established, producing an initial cohort of student-led start-ups, including early female-led ventures
5. The Labour Market Observatory and industry mentorship network become operational, giving the system its first structured channel of employer feedback and career guidance

Phase 2: 2029–2031 — Scale-Up and Consolidation

1. Industry partnerships and curriculum co-design extend across most STEM faculties, with a nationally consistent 2-year curriculum review cycle in place
2. A majority of eligible students complete quality-assured work-integrated learning placements, with female participation rising markedly and employer satisfaction improving
3. University–industry research collaboration and technology transfer activity expand significantly, deepening the flow of applied innovation into the productive sector
4. The entrepreneurship ecosystem matures, with a growing, increasingly gender-diverse pipeline of graduate-founded, technology-driven enterprises
5. The Labour Market Observatory produces regular, sector-disaggregated evidence that actively informs curriculum decisions, and a majority of industry partners adopt the Gender-Responsive Workplace Charter

Phase 3: 2032–2035+ — Institutionalisation and Sustainability

1. University–industry linkages are fully institutionalised and self-sustaining, with near-universal industry-aligned curricula across STEM programmes
2. Work-integrated learning achieves near-universal completion with gender parity in placements, and graduates enter the workforce demonstrably industry-ready
3. Nigeria's universities operate as mature, continuous sources of applied research, innovation, and technology transfer for the productive sector
4. A robust, self-financing entrepreneurship ecosystem consistently produces graduate-founded ventures, with strong and sustained female participation
5. Real-time labour-market intelligence, mentorship, and gender-responsive workplace standards are fully mainstreamed, closing the gap between STEM education and equitable, high-quality employment

4.8 Cumulative Expected Impact

Taken together, and sustained across all three implementation phases, the interventions in this section are expected to deliver the following cumulative, long-term impacts on Nigeria's STEM higher education system and its productive sectors by 2035 and beyond:

1. **Workforce Readiness and Employability:** Graduates enter the workforce with industry-validated skills and practical experience, reducing skills mismatch and improving employment outcomes across ICT, engineering, healthcare, agriculture, and manufacturing.
2. **A Stronger National Innovation System:** A sustained flow of applied research, technology transfer, and industry-informed curricula strengthens Nigeria's STEM innovation ecosystem and its competitiveness in an Industry 4.0-driven global economy.
3. **Expanded Entrepreneurship and Job Creation:** A growing, increasingly diverse pipeline of graduate-founded, technology-driven enterprises contributes directly to job creation, economic diversification, and local value addition.
4. **Institutionalised, Evidence-Based Curriculum Renewal:** The Labour Market Observatory embeds continuous, evidence-based curriculum review as standard practice, keeping STEM education responsive to a changing economy well beyond the life of this strategy.
5. **A Gender-Equitable STEM-to-Workforce Pathway:** Safe, well-supported, and increasingly gender-balanced participation in placements, mentorship, and entrepreneurship narrows the gender gap in STEM careers and expands the pool of female innovators and industry leaders.
6. **Durable, Self-Sustaining University–Industry Partnerships:** By the end of the strategy period, universities and industry operate as mutually reinforcing, financially sustainable partners, reducing long-term dependence on donor or one-off government funding.

Collectively, these impacts close the long-standing gap between STEM education and the productive sector — producing graduates who are industry-ready, universities that are engines of applied innovation, and an economy that is more competitive, diversified, and equitable as a direct result of closer academia–industry collaboration.

CHAPTER FIVE

RESEARCH AND TECHNOLOGY TRANSFER IN STEM STRATEGIC AREAS

5.1 Talent Development

Introduction

Talent development is the backbone of any meaningful ICT–STEM transformation in Nigeria's higher education system. To make it effective, it must go beyond traditional teaching and deliberately build a pipeline of skilled, innovative, and industry-ready graduates. The National ICT enabled STEM Transformation Strategy is to create an Inclusive Talent Development which is a deliberate approach to identifying, nurturing, and advancing people's skills and potential **across all segments of society**, ensuring that no group is excluded due to barriers like gender, disability, socioeconomic status, geography, or ethnicity. Inclusive talent development ensures that everyone has access to opportunities to learn and grow; barriers are removed so disadvantaged groups can participate fully and diverse talents are recognized and supported, not just the traditional or elite pathways. Generally, it moves from a "one-size-fits-all" model to a personalized, and equitable system

Vision

"To create an equitable, diverse, and high-performing talent ecosystem in Nigerian higher education institutions that ensures access, participation, retention, and success for all student groups especially women and the underrepresented populations in STEM and emerging fields"

Mission

To transform Nigeria's higher education system through inclusive, high-quality ICT-enabled STEM education by strengthening teaching and learning, advancing research and innovation, accelerating talent development, promoting entrepreneurship, expanding digital infrastructure, and fostering strategic partnerships among government, academia, industry, and development partners to produce globally competitive graduates and solutions for national development

Strategic goals

The strategic goals with the desired outcomes to create a pipeline for inclusive Talent Development for ICT-STEM transformation in higher education is presented in Table 5.1.

Table 5.1: Strategic goals with the desired outcomes to create a pipeline for inclusive talent development for ICT-STEM transformation in higher education

	Strategic Goal	Desired Outcome
1	Expand Equitable Access	All talented Nigerians have equal opportunities to participate and succeed in ICT–STEM education.
2	Establish a National Talent Identification System	High-potential learners are systematically identified, nurtured, and supported throughout their educational journey.
3	Strengthen Mentorship, Leadership, and Talent Acceleration	Students receive structured guidance, leadership development, and accelerated pathways to excellence.
4	Build Future-Ready Digital and Technical Competencies	Graduates possess advanced technical, digital, and employability skills aligned with future workforce needs.
5	Foster Innovation, Research, and Entrepreneurship	Students become innovators, researchers, and entrepreneurs capable of solving national and global challenges.
6	Strengthen Industry, Community, and Global Partnerships	Strong partnerships provide practical experience, mentorship, and global opportunities.
7	Promote Lifelong Learning and Continuous Talent Development	Graduates and professionals continuously upgrade their skills to remain competitive in a rapidly evolving economy.
8	Strengthen Governance, Monitoring, and Sustainable Financing	Inclusive talent development is supported by effective governance, sustainable investment, and evidence-based management.

Strategic Activities

The strategic activities, programmes, and key performance indicators (KPIs) for the **Inclusive Talent Development** component provide a comprehensive implementation framework for building a diverse, equitable, and future-ready ICT–STEM workforce in Nigeria's higher education system. The framework focuses on identifying and nurturing talent, expanding equitable access to quality STEM education, strengthening mentorship and talent acceleration, enhancing digital and technical competencies, promoting research and innovation, fostering industry and international partnerships, supporting lifelong learning, and ensuring effective governance and sustainable financing. Collectively, these interventions are designed to create an enabling ecosystem that empowers all learners particularly women, persons with disabilities, and students from underserved communities to realize their full potential and contribute to Nigeria's digital transformation, economic competitiveness, and sustainable national development. The strategic intervention activity component with the programmes and performance indicators towards achieving the strategic goals is presented in Table 5.2.

Table 5.2: Strategic Activities, Programmes and KPIs for the Inclusive Talent Development Component of Nigeria's ICT–STEM Transformation Strategy

Strategic Goal	Strategic Activities	Programme(s)	Key Performance Indicators (KPIs)
1. Expand Equitable Access to ICT–STEM Talent Development Opportunities	Develop inclusive participation policies; expand scholarships and financial aid; increase participation of women, persons with disabilities and underserved communities;	National Inclusive STEM Participation Programme; ICT–STEM Scholarship and Financial Support Scheme; Women in ICT–STEM Initiative; Inclusive STEM Accessibility Programme; Rural STEM Talent Outreach Programme; Digital	National policy approved and implemented. Number of scholarship beneficiaries Female STEM enrolment (%). Number of students with disabilities enrolled Number of students from underserved communities enrolled. Number of students accessing digital learning platforms

	strengthen digital and flexible learning	Learning Access Programme	
2. Establish a National STEM Talent Identification and Development System	Develop national talent identification framework; establish Talent Development Offices; create national digital talent database; implement student e-portfolios; organize national STEM competitions	National STEM Talent Identification Initiative; Institutional Talent Development Programme; National Digital Talent Registry; Student e-Portfolio Programme; National ICT–STEM Challenge Series	Talent identification framework operational Percentage of institutions with Talent Development Offices. Number of students registered in the national talent database. Percentage of students with digital portfolios. Number of STEM competitions conducted annually. Number of participants in competitions
3. Strengthen Mentorship, Leadership and Talent Acceleration	Establish mentorship programmes; recruit academic, industry and alumni mentors; implement Talent Accelerator Programmes; provide leadership and career coaching; support participation in national and international competitions	National STEM Mentorship Programme; National Mentor Network; ICT–STEM Talent Accelerator Programme; STEM Leadership Development Programme; Global STEM Mobility Programme	Number of mentor–mentee pairs established. Number of active mentors. Number of students completing accelerator programmes Number of students completing leadership programmes. Number of students participating in international fellowships and competitions. Graduate satisfaction with mentorship
4. Build Future-Ready Digital and Technical Competencies	Integrate digital competencies into STEM curricula; embed industry certifications; organize boot camps and hackathons; promote project-based learning; strengthen employability and soft skills	Digital Skills Integration Initiative; National ICT Certification Programme; Digital Skills Bootcamp Programme; Applied Learning Programme; Graduate Employability Skills Programme	Percentage of STEM programmes with digital competencies. Number of industry certifications earned. Number of hackathons and boot camps conducted. Percentage of students completing project-based learning. Graduate employability rate Employer satisfaction rate
5. Foster Innovation, Research and Entrepreneurship	Establish innovation hubs and makerspaces; provide innovation grants; support startup incubation; commercialize research; organize innovation fairs	University Innovation Hub Programme; Student Innovation Fund; Campus Startup Accelerator; Technology Commercialization Initiative; National Innovation Showcase	Number of innovation hubs established. Number of student innovation projects funded. Number of startups incubated. Number of patents filed/commercialized Number of innovation exhibitions conducted External innovation funding secured
6. Strengthen Industry, Community and Global Partnerships	Expand internships and industrial attachments; establish university–industry partnerships; engage industry experts as mentors; strengthen international collaborations; implement community innovation projects	Enhanced SIWES and Internship Programme; Industry Partnership Initiative; Industry Fellows Programme; Global STEM Exchange Programme; Community STEM Solutions Programme	Percentage of students completing internships Number of industry partnership agreements Number of industry experts participating. Number of international collaborations Number of community innovation projects implemented. Graduate employment within 12 months
7. Promote Lifelong Learning and	Develop micro-credentials; expand	National Micro-Credential Initiative; STEM	Number of learners earning micro-credentials. Number of

Continuous Talent Development	continuing professional development; establish alumni mentoring; develop digital lifelong learning platforms; support career transition programmes	Professional Development Programme; STEM Alumni Engagement Programme; National STEM Digital Learning Platform; Career Advancement Programme	professionals trained annually. Number of active alumni mentors. Number of users on lifelong learning platforms. Graduate career progression rate .Lifelong learning participation rate
8. Strengthen Governance, Monitoring and Sustainable Financing	Establish National ICT–STEM Talent Development Council; develop institutional implementation frameworks; strengthen monitoring and evaluation; mobilize sustainable funding; conduct programme evaluations	National Talent Governance Programme; Institutional Capacity Strengthening Programme; National Talent Development Monitoring and Evaluation System; STEM Talent Development Fund; Impact Assessment Programme	National Council established and operational Percentage of institutions implementing annual talent plans Annual monitoring reports produced Amount of funding mobilized annually Percentage of KPIs achieved Number of programme evaluations completed and recommendations implemented

Responsibilities

The successful implementation of the **Inclusive Talent Development** component requires coordinated action among federal and state governments, regulatory agencies, higher education institutions, industry, professional bodies, development partners, and civil society organizations. The responsibility matrix below identifies the lead and supporting institutions for each strategic activity and specifies the primary level of implementation to ensure accountability, coordination, and effective delivery across Nigeria's higher education system. The different levels of implementing organization and their responsibilities are presented in Table 5.3.

Table 5.3: Responsibility Matrix for the Inclusive Talent Development Component of Nigeria's ICT–STEM Transformation Strategy

Strategic Activity	Lead Institution(s)	Supporting Institution(s)	Implementation Level (National, State, Institutional)
Develop and implement the National Inclusive ICT–STEM Talent Development Policy	Federal Ministry of Education (FME)	National Universities Commission (NUC), National Board for Technical Education (NBTE), National Commission for Colleges of Education (NCCE), Federal Ministry of Communications, Innovation and Digital Economy	National
Establish the National ICT–STEM Talent Development Council	Federal Ministry of Education	NUC, NBTE, NCCE, TETFund, National Information Technology Development Agency (NITDA), private sector representatives	National

Establish Talent Development Offices in universities, polytechnics and colleges of education	Higher Education Institutions	NUC, NBTE, NCCE, TETFund	Institutional
Develop a National STEM Talent Identification Framework and Digital Talent Registry	Federal Ministry of Education, NUC	NBTE, NCCE, NITDA, Joint Admissions and Matriculation Board (JAMB), Higher Education Institutions	National
Create student digital talent portfolios and talent tracking systems	Higher Education Institutions	NUC, NBTE, NCCE, NITDA	Institutional
Expand scholarships, bursaries and financial aid for underrepresented groups	Federal Ministry of Education	TETFund, Federal Scholarship Board, State Ministries of Education, Private Foundations, Development Partners	National/State
Promote women and girls' participation in ICT–STEM	Federal Ministry of Women Affairs, Federal Ministry of Education	NUC, Higher Education Institutions, NGOs, Professional Associations	National/State/Institutional
Strengthen inclusion of persons with disabilities in STEM education	Federal Ministry of Education	National Commission for Persons with Disabilities, Higher Education Institutions, State Governments	National/State/Institutional
Establish the National STEM Mentorship Programme	Higher Education Institutions	Federal Ministry of Education, Professional Bodies, Alumni Associations, Industry Partners	Institutional
Recruit academic, industry and alumni mentors	Higher Education Institutions	Professional Associations, Private Sector, Alumni Networks	Institutional
Implement ICT–STEM Talent Accelerator Programmes	Higher Education Institutions	TETFund, Industry Partners, Innovation Hubs, Development Partners	Institutional
Organize leadership development, career coaching and employability programmes	Higher Education Institutions	National Universities Commission, Industry Partners, Professional Bodies	Institutional
Integrate digital competencies and industry certifications into STEM programmes	NUC, NBTE, NCCE	Higher Education Institutions, Industry Certification Providers, NITDA	National/Institutional
Organize digital skills boot camps, hackathons and coding competitions	Higher Education Institutions	NITDA, Industry Partners, Innovation Hubs, Professional Associations	Institutional
Establish innovation hubs, makerspaces and entrepreneurship centres	TETFund	Higher Education Institutions, State Governments, Private Sector, Development Partners	National/Institutional
Provide student innovation grants and	TETFund	Bank of Industry, SMEDAN, Nigerian Universities	National/Institutional

startup incubation support		Commission, Development Partners	
Strengthen university–industry partnerships and work-integrated learning	Higher Education Institutions	Manufacturers Association of Nigeria (MAN), Nigerian Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA), Private Sector	Institutional
Expand internships and industrial attachment programmes	Industrial Training Fund (ITF)	Higher Education Institutions, Industry Partners, Federal Ministry of Labour and Employment	National/Institutional
Promote international exchange programmes and research collaborations	Federal Ministry of Education	Higher Education Institutions, International Development Partners, Foreign Universities	National/Institutional
Develop lifelong learning, micro-credential and continuing professional development programmes	Higher Education Institutions	NUC, NBTE, NCCE, Professional Bodies, Industry Partners	Institutional
Develop national monitoring, evaluation and learning framework	Federal Ministry of Education	NUC, NBTE, NCCE, National Bureau of Statistics (NBS), TETFund	National
Conduct annual monitoring, evaluation and impact assessments	Federal Ministry of Education	NUC, NBTE, NCCE, Higher Education Institutions, Independent Evaluators	National/Institutional
Mobilize sustainable funding for talent development programmes	Federal Ministry of Education	Ministry of Finance, TETFund, State Governments, Development Partners, Private Sector	National/State
Promote advocacy, stakeholder engagement and public awareness	Federal Ministry of Education	Higher Education Institutions, Media Organizations, Civil Society Organizations, Professional Associations	National/State/Institutional

Key Performance Indicators

Inclusive Talent Development Strategy under Nigeria's ICT–STEM Transformation in Higher Education, the Key Performance Indicators (KPIs measures **access,** quality, equity, talent development, employability, innovation, and sustainability**.** The targets in Table 5.3 are **illustrative national targets** that can be refined once a baseline assessment is completed by the Federal Ministry of Education, the National Universities Commission (NUC), the National Board for Technical Education (NBTE), the National Commission for Colleges of Education (NCCE), and the (NBS).

Table 5.4: Key Performance indicator for inclusive Talent Development

Strategic Goal	Key Performance Indicator (KPI)	Baseline (2026)*	Short-Term Target (2028)	Medium-Term Target (2031)	Long-Term Target (2035)
1. Expand Equitable Access	Total enrolment in ICT–STEM programmes	1.0 million	1.25 million	1.60 million	2.00 million
	Female enrolment in ICT–STEM (%)	35%	40%	45%	50%
	Students from underserved/rural areas (%)	20%	25%	32%	40%
	Students with disabilities enrolled (%)	1%	2%	3%	5%
	Students receiving STEM scholarships annually	50,000	75,000	120,000	200,000
2. Talent Identification & Development	Institutions with Talent Development Offices (%)	10%	40%	80%	100%
	Students enrolled in structured mentorship programmes	20,000	200,000	600,000	1,000,000
	Students participating in Talent Accelerator Programmes	5,000	50,000	150,000	300,000
	Students with digital talent portfolios (%)	5%	40%	80%	100%
3. Digital & Technical Skills	Students earning industry-recognised ICT certifications	10,000	100,000	350,000	700,000
	STEM programmes with embedded digital competencies (%)	25%	60%	90%	100%
	Students completing project-based learning (%)	30%	60%	85%	100%
4. Mentorship & Leadership	Active mentor-to-student ratio	1:100	1:40	1:20	1:10
	Industry mentors engaged	500	3,000	8,000	15,000
	Students completing leadership development programmes	10,000	100,000	300,000	600,000
5. Research, Innovation & Entrepreneurship	Student-led startups created	200	800	2,500	5,000
	Student patents filed	50	250	800	1,500
	Universities with innovation hubs (%)	20%	50%	80%	100%
	Students participating in innovation competitions annually	15,000	60,000	120,000	250,000
6. Industry & Global Partnerships	Students completing quality internships/work-integrated learning (%)	45%	65%	85%	100%
	Active university–industry partnership agreements	150	500	1,000	2,000
	Students participating in international exchanges/fellowships	2,000	8,000	20,000	40,000

7. Graduate Outcomes	ICT–STEM graduate employment within 12 months	45%	60%	75%	90%
	Graduates employed in ICT-intensive occupations	30%	45%	60%	75%
	Graduate satisfaction with career readiness	60%	75%	85%	95%
8. Governance & Sustainability	Institutions implementing annual talent development plans (%)	15%	50%	90%	100%
	Annual funding for talent development (₦ billions)	50	150	300	500
	Institutions publishing annual talent development performance reports (%)	10%	50%	90%	100%

Timelines for Phase Implementation for Talent Development

The implementation of the **Inclusive Talent Development** component will follow a **three-phase approach** over a ten-year period (2026–2036). The phased approach enables the gradual establishment of governance structures, capacity building, programme expansion, and institutionalization of talent development initiatives across Nigeria's higher education system. The timeline ensures that foundational activities are completed before nationwide scaling and long-term sustainability are achieved.

Table 5.5: Timelines for Phase Implementation for Talent Development

Phase	Period	Primary Focus	Key Deliverables
Phase I: Foundation and Pilot	**2026–2028**	Policy development, governance structures, pilot programmes, institutional capacity building	National policy adopted; Talent Development Council established; Talent Development Offices in at least 40% of institutions; mentorship and accelerator pilots launched; digital talent registry designed; inclusive scholarship programmes initiated
Phase II: Scale-up and Integration	**2029–2031**	National expansion of programmes, integration into institutional systems, strengthened partnerships	Talent Development Offices operational in at least 80% of institutions; nationwide mentorship and talent accelerator programmes; innovation hubs expanded; industry partnerships strengthened; digital competencies integrated into STEM curricula
Phase III: Institutionalization and Sustainability	**2032–2035**	Full institutionalization, quality enhancement, global competitiveness, sustainability	Talent Development Offices in all institutions; fully operational national talent ecosystem; sustainable financing; internationally competitive STEM graduates; strong research, innovation, entrepreneurship, and industry collaboration

Expected Outcomes for Talent Development

Phase I (Short-Term: 2026–2028)

Expected Outcomes

1. Inclusive talent development policy adopted nationally.
2. Talent Development Offices established in at least 40% of higher education institutions.
3. National mentorship and talent accelerator programmes launched.
4. Digital skills integrated into most STEM curricula.
5. Significant increase in female and underserved student participation.

Phase II (Medium-Term: 2029–2031)

Expected Outcomes

1. National ICT–STEM talent pipeline operational across universities, polytechnics, and colleges of education.
2. Strong university–industry partnerships supporting internships and research.
3. Innovation hubs operational in most institutions.
4. Graduate employability exceeds 75%.

Phase III (Long-Term: 2032–2035)

Expected Outcomes

1. Nigeria recognised as a leading African hub for ICT–STEM talent.
2. Gender parity achieved in STEM enrolment.
3. All higher education institutions operating structured mentorship and talent acceleration programmes.
4. High levels of graduate employment, innovation, startup creation, and research commercialization.
5. A sustainable national ecosystem for inclusive STEM talent development firmly established.

5.2 Research Infrastructure and Digital Transformation

Introduction

Nigeria’s aspiration to become a knowledge-driven, innovation-led economy is significantly constrained by weak research and digital infrastructure in higher education. Despite having over 600 tertiary institutions and one of the largest youth populations globally, the country’s research and digital infrastructure is characterised by underfunded and fragmented system, weak ICT and research infrastructure capacity, limited national coordination (no strong shared infrastructure system), heavy reliance on government intervention funds (e.g., TETFund), Outdated laboratory systems, Limited access to modern scientific equipment, weak digital research infrastructure (HPC, data systems, repositories), Poor maintenance culture and infrastructure sustainability and minimal industry–academia collaboration. Nigeria's STEM

Transformation Strategy is therefore prioritizing sustained investment in modern research infrastructure, nationwide broadband connectivity for higher education institutions, digital research ecosystems, cybersecurity, open science initiatives, research equipment modernization, and human capacity development in digital research skills. Developing shared infrastructure and promoting equipment-sharing mechanisms among universities and research institutions can significantly improve resource utilization while reducing duplication of costly investments. These investments will enhance research excellence, foster stronger university–industry collaboration, attract international research partnerships, and position Nigeria as a leading innovation and knowledge economy in Africa.

Vision

"To build a modern, interconnected, and digitally transformed research ecosystem that positions Nigeria as Africa's leading hub for STEM research, innovation, and knowledge creation".

Mission

"To modernize and expand research infrastructure across Nigeria's higher education institutions by investing in state-of-the-art laboratories, shared research facilities, advanced digital technologies, high-speed research networks, open science platforms, and human capital development, while fostering collaboration among academia, industry, government, and international partners to accelerate scientific discovery, innovation, commercialization, and sustainable national development."

Strategic Goals

The Research Infrastructure and Digital Transformation component seeks to establish a modern, technology-enabled research ecosystem that supports high-quality scientific research, innovation, commercialization, and evidence-based decision-making across Nigeria's higher education institutions. The following strategic goals and desired outcomes provide the foundation for transforming research capacity and positioning Nigeria as a regional leader in STEM research and innovation (Table 5.6).

Table 5.6: Strategic goals for Research Infrastructure and digital transformation in the STEM transformation Strategy for Higher Education in Nigeria

Strategic Goal	Desired Outcomes
1. Modernize Research Infrastructure Across Higher Education Institutions	Modernise laboratories, workshops, research farms, pilot plants, maker spaces, and innovation centres established and upgraded to international standards across universities, polytechnics, and colleges of education.
2. Establish a National Shared Research Infrastructure Network	National system for shared access to high-value scientific equipment, laboratories, and specialized research facilities operational, reducing duplication and improving utilization.
3. Accelerate Digital Transformation of Research Systems	Digital research ecosystems established through integrated Research Information Management Systems (RIMS), electronic laboratory notebooks, digital repositories, and cloud-based research platforms.
4. Expand High-Speed Research and Education Connectivity	All higher education institutions connected to reliable high-speed broadband through a National Research and Education Network (NgREN), enabling seamless collaboration, remote experimentation, and access to global scientific resources.
5. Develop Advanced Digital Research Capabilities	Researchers equipped with artificial intelligence (AI), machine learning, big data analytics, Internet of Things (IoT), geographic information systems (GIS), robotics, digital modelling, and high-performance computing (HPC) capabilities.
6. Strengthen Open Science and Research Data Management	National open science framework implemented with institutional repositories, research data centres, FAIR (Findable, Accessible, Interoperable, and Reusable) data standards, and improved visibility of Nigerian research outputs.
7. Enhance Research Equipment Management and Sustainability	Efficient systems for procurement, maintenance, calibration, utilization, lifecycle management, and technical support for research equipment institutionalized across higher education institutions.
8. Promote University–Industry–Government Digital Collaboration	Digital innovation platforms and collaborative research environments strengthen partnerships among academia, industry, government agencies, and international research organizations.
9. Strengthen Research Cybersecurity and Digital Governance	Robust cybersecurity frameworks, data protection policies, digital ethics guidelines, and secure research information systems safeguard research integrity and intellectual property.
10. Build Human Capacity for Digital Research and Innovation	Researchers, technical staff, librarians, and research administrators acquire advanced digital competencies in emerging technologies, digital research methods, scientific computing, and research data management.
11. Foster Technology Commercialization through Digital Innovation	Increased commercialization of research outputs through technology transfer offices, innovation hubs, incubators, digital entrepreneurship platforms, and stronger intellectual property management systems.
12. Promote Equitable Access to Research Infrastructure	Institutions in underserved regions gain equitable access to modern research facilities, digital platforms, shared laboratories, and scientific equipment, reducing regional disparities.
13. Strengthen Research Monitoring, Evaluation, and Decision Support	Real-time national research databases, digital performance dashboards, and evidence-based monitoring systems improve research governance, funding decisions, and policy implementation.
14. Increase International Research Collaboration	Nigerian institutions participate more actively in global research networks, multinational projects, virtual laboratories, and international funding programmes through enhanced digital connectivity and infrastructure.
15. Support Sustainable and Green Research Infrastructure	Research facilities adopt energy-efficient technologies, renewable energy systems, sustainable laboratory practices, green buildings, and environmentally responsible waste management systems.

Strategic Activities

Table 5.7 links each strategic goal to programmes, key activities, and measurable Key Performance Indicators (KPIs).

Table 5.7: Activities and Programmes for Research infrastructure and Digital Transformation of STEM Higer Education in Nigeria

	Activities	Programme	Key Performance Indicators (KPIs)
1	Upgrade laboratories, workshops, pilot plants, and research farms. Procure modern scientific equipment. Renovate research facilities. Establish multidisciplinary research centres and upgrade existing ones	National Research Infrastructure Modernization	Number of laboratories upgraded. % of institutions meeting minimum research infrastructure standards. Value of research infrastructure investment. Number of new research centres established
2	Develop national equipment inventory database. Create regional shared research facilities. Establish equipment booking system. Develop cost-recovery framework	National Shared Scientific Equipment	National equipment database operational. Number of shared facilities established. Equipment utilization rate (%). Number of institutions accessing shared facilities
3	Deploy Research Information Management Systems (RIMS). Implement electronic laboratory notebooks. Digitize research administration. Develop institutional repositories	Digital Research Ecosystem, Expansion of TERAS	Number of institutions using RIMS. % research records digitized. Number of institutional repositories established. User satisfaction rate
4	Upgrade broadband connectivity. Connect institutions to NgREN. Expand campus Wi-Fi and Improve internet redundancy	National Research and Education Network (NgREN) Expansion Programme	% institutions connected to NgREN. Average internet speed (Mbps/Gbps). Network uptime (%). Number of researchers accessing digital resources.
5	Establish AI laboratories. Procure HPC facilities. Introduce robotics and IoT laboratories. Develop GIS and data science centres	Emerging Technologies Research Programme	Number of AI/HPC centres established. Number of researchers trained. Number of AI-enabled research projects . HPC utilization rate.
6	Develop Open Science Policy. Create institutional repositories. Establish research data repositories. Implement FAIR data standards	National Open Science Initiative	National Open Science Policy adopted. Number of datasets published. % publicly funded research openly accessible. Repository downloads.
7	Establish maintenance centres. Train laboratory technologists. Implement equipment asset management system. Schedule calibration	Scientific Equipment Management Programme	Equipment uptime (%). Number of certified technicians. Equipment maintenance compliance (%). Equipment downtime reduced.
8	Create collaborative digital platforms. Develop industry research portals. Launch joint innovation projects. Facilitate virtual collaboration	Digital Innovation Partnership Programme	Number of industry partnerships. Joint research projects completed. Industry funding secured. Collaborative publications.
9	Develop cybersecurity policies. Deploy secure cloud systems. Conduct cybersecurity audits, Train researchers on data protection	Research Cybersecurity Programme	Institutions with cybersecurity framework. Number of cyber incidents. Compliance with data protection standards. Staff trained

10	Train researchers in AI, HPC, GIS, programming, data analytics. Develop digital literacy curriculum. Train research managers	National Digital Research Skills Programme. UNDP UNIPod	Number of researchers trained. Digital competency scores. Number of certifications awarded Percentage of institutions implementing training
11	Strengthen Technology Transfer Offices (TTOs). Develop innovation hubs. Support spin-offs and startups Digital IP management	Digital Innovation and Commercialization Programme. Project BRIDGE expansion and UNDP UNIPod	Number of patents filed. Number of startups created. Licensing agreements signed. Commercialization revenue
12	Provide targeted grants to underserved institutions. Establish regional centres of excellence. Improve digital access in disadvantaged regions	Inclusive Research Infrastructure Programme	Number of underserved institutions upgraded. Regional distribution index. Research infrastructure access ratio. Broadband coverage (%)
13	Develop national research dashboard. Integrate institutional databases. Produce annual research reports. Monitor institutional performance	Research Intelligence and Analytics Programme	National dashboard operational. Annual performance reports produced. Institutions reporting digitally. Data quality index
14	Connect institutions to global research networks. Facilitate virtual research collaborations Support participation in international consortia	Global Digital Research Collaboration Programme	Number of international collaborations. International grants secured. Joint publications Number of mobility programmes
15	Install renewable energy systems. Develop green laboratories. Improve laboratory waste management Implement energy-efficient buildings	Green Research Infrastructure Programme	% laboratories powered by renewable energy. Carbon emissions are reduced. Green laboratory certifications. Laboratory waste recycled (%)

Responsibility

The successful implementation of the Research Infrastructure and Digital Transformation component requires coordinated action by government ministries, regulatory agencies, tertiary education institutions, research organizations, industry, development partners, and the private sector. The Table 5.8 below outlines the primary and supporting responsibilities of key stakeholders.

Table 5.8: Responsibility Matrix for the Implementation of the Research Infrastructure and Digital Transformation Component

Strategic Programme	Lead Institution(s)	Supporting Institutions	Key Responsibilities
1. National Research Infrastructure Modernization Programme	Federal Ministry of Education (FME); Tertiary Education Trust Fund (TETFund)	National Universities Commission (NUC); National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); Federal Ministry of Science, Innovation and Technology (FMSTI); State Ministries of Education; Higher Education Institutions (HEIs)	Develop infrastructure standards; mobilize funding; modernize laboratories and workshops; monitor implementation.
2. National Shared Scientific Equipment Programme	TETFund; FMSTI	NUC; NBTE; NCCE; National Research Institutes; HEIs	Establish national equipment inventory; coordinate regional shared facilities;

			develop access and maintenance policies.
3. Digital Research Ecosystem Programme	FME	NUC; NBTE; NCCE; National Information Technology Development Agency (NITDA); Nigerian Research and Education Network (NgREN); HEIs	Deploy Research Information Management Systems (RIMS); digitize research administration; establish institutional repositories.
4. National Research and Education Network Expansion Programme	Federal Ministry of Communications, Innovation and Digital Economy (FMCIDE); NgREN	Nigerian Communications Commission (NCC); Galaxy Backbone; NITDA; HEIs; Internet Service Providers (ISPs)	Expand broadband infrastructure; connect institutions; improve network resilience and cybersecurity.
5. Emerging Technologies Research Programme	FMSTI	FME; TETFund; NUC; NITDA; National Centre for Artificial Intelligence and Robotics (NCAIR); HEIs; Industry	Establish AI, robotics, IoT, HPC, and advanced manufacturing laboratories; support research in frontier technologies.
6. National Open Science Initiative	FME	NUC; National Library of Nigeria; TETFund; HEIs; Research Institutes	Develop open science policy; establish digital repositories; promote research data sharing and FAIR data principles.
7. Scientific Equipment Management Programme	TETFund	FMSTI; Standards Organisation of Nigeria (SON); HEIs; Equipment Suppliers	Develop equipment lifecycle management systems; strengthen maintenance, calibration, and technical support.
8. Digital Innovation Partnership Programme	FMSTI	Bank of Industry (BOI); Nigerian Sovereign Investment Authority (NSIA); Industry Associations; HEIs; Innovation Hubs	Promote university–industry collaboration; fund joint research projects; strengthen technology transfer.
9. Research Cybersecurity Programme	NITDA	National Information Technology Development Agency Computer Emergency Readiness Team (NITDA-CERT); Office of the National Security Adviser (ONSA); Galaxy Backbone; HEIs	Develop cybersecurity standards; secure research infrastructure; build institutional cyber resilience.
10. National Digital Research Skills Programme	FME	NUC; NBTE; NCCE; TETFund; HEIs; Professional Bodies	Develop curricula; deliver digital skills training for researchers, technicians, and administrators.
11. Innovation and Commercialization Programme	FMSTI	BOI; Nigerian Export Promotion Council (NEPC); TETFund; HEIs; Industry	Strengthen Technology Transfer Offices (TTOs); support incubation, patenting, licensing, and startup creation.
12. Inclusive Research	FME	NUC; NBTE; NCCE; State Governments; TETFund	Ensure equitable distribution of research

Infrastructure Programme			infrastructure; support underserved institutions and regions.
13. Research Intelligence and Analytics Programme	National Universities Commission (NUC)	FME; NBTE; NCCE; National Bureau of Statistics (NBS); TETFund; HEIs	Develop national research dashboards; collect and analyse performance data; support evidence-based policymaking.
14. Global Research Collaboration Programme	FMSTI; Federal Ministry of Education	Nigerian universities; Research Institutes; International Development Partners; African Union; ECOWAS	Facilitate international research partnerships; coordinate participation in multinational programmes; mobilize external funding.
15. Green Research Infrastructure Programme	Federal Ministry of Environment (FMEv); FMSTI	Rural Electrification Agency (REA); Energy Commission of Nigeria (ECN); TETFund; HEIs	Promote renewable energy, green laboratories, sustainable procurement, and environmentally responsible laboratory practices.

Table 5.9: Cross-Cutting Governance Responsibilities for Research Infrastructure and Digital Transformation

Level	Organisation	Primary Responsibility
Federal	Federal Ministry of Education (FME)	Overall policy leadership, coordination, implementation oversight, inter-ministerial collaboration, and monitoring of the STEM Transformation Strategy.
Federal	Tertiary Education Trust Fund (TETFund)	Financing research infrastructure, equipment procurement, digital transformation initiatives, capacity building, and research grants.
Federal	National Universities Commission (NUC)	Quality assurance, institutional regulation, monitoring compliance with infrastructure and digital transformation standards in universities.
Federal	National Board for Technical Education (NBTE)	Oversight of polytechnics and technical institutions; implementation of infrastructure and digital transformation standards.
Federal	National Commission for Colleges of Education (NCCE)	Oversight of colleges of education; integration of digital research infrastructure and STEM capacity development.
Federal	Federal Ministry of Science, Innovation and Technology (FMSTI)	National research and innovation policy; coordination of research institutes; promotion of technology development and commercialization.
Federal	Federal Ministry of Communications, Innovation and Digital Economy (FMCIDE)	Digital infrastructure policy, broadband expansion, digital inclusion, and innovation ecosystem development.
Federal	NITDA	Digital standards, cybersecurity, digital capacity building, AI policy implementation, and digital governance.
Federal	NgREN	Provision of high-speed research and education network services, digital collaboration platforms, and access to global research networks.

	Higher Education Institutions (Universities, Polytechnics, and Colleges of Education)	Institutional implementation, infrastructure management, digital transformation, research delivery, maintenance of facilities, and performance reporting.
	Research Institutes	Specialized research, shared infrastructure management, technical support, and national research collaboration.
	Private Sector and Industry	Co-investment, collaborative research, technology commercialization, internships, and innovation partnerships.
International	Development Partners and Donors	Technical assistance, capacity building, infrastructure financing, knowledge exchange, and support for international collaboration.
	Professional Bodies and Scientific Associations	Accreditation support, professional standards, continuing professional development, and technical advisory services.
State	State Governments	Co-funding, complementary infrastructure development, support for state-owned institutions, and alignment with national priorities.

Key Performance Indicators

The KPIs are designed to measure progress in implementing the **Research Infrastructure and Digital Transformation** component of Nigeria's STEM Transformation Strategy. The targets are indicative and can be refined using a comprehensive national baseline assessment during the first year of implementation. They are structured into **Baseline (2026), Short-Term (2028), Medium-Term (2031), and Long-Term (2035)** targets Table 5.10).

Table 5.10: Key Performance Indicators (KPIs) for Research Infrastructure and Digital Transformation

KPI	Baseline (2026)	Short-Term Target (2028)	Medium-Term Target (2031)	Long-Term Target (2035)
Higher education institutions meeting national minimum research infrastructure standards	30%	50%	75%	100%
Modern STEM laboratories established or upgraded	500	1,000	2,000	3,000
Regional shared research facilities established	6	12	24	37 (36 States + FCT)
National research equipment inventory operational	No	Yes	Fully integrated	AI-enabled national platform
Average research equipment utilization rate	35%	55%	75%	90%
Research equipment uptime	60%	75%	85%	95%
Institutions using Research Information Management Systems (RIMS)	15%	50%	80%	100%
Institutions with institutional digital repositories	25%	60%	85%	100%
Publicly funded research available through open-access repositories	20%	50%	75%	100%

Institutions connected to the Nigerian Research and Education Network (NgREN)	40%	70%	90%	100%
Institutions connected to TERAS	5%	40%	80%	100%
Institutions with Unipods	10%	40%	80%	100%
Institutions connected to BRIDGE	5%	40%	80%	100%
Institutions implementing iDICE	5%	40%	80%	100%
Average broadband speed available for research	100 Mbps	500 Mbps	2 Gbps	≥10 Gbps
Campus-wide Wi-Fi coverage	35%	60%	85%	100%
Cloud-based research platforms operational	15%	50%	80%	100%
AI, High-Performance Computing (HPC), and Data Science Centres established	10	25	50	75
Researchers trained in AI, data science, HPC, GIS, and digital research methods	5,000	25,000	75,000	150,000
Technical staff trained in laboratory equipment maintenance	1,500	5,000	10,000	20,000
Digital research skills certification rate	10%	35%	65%	90%
Universities implementing electronic laboratory notebooks	5%	30%	70%	100%
Institutions with integrated cybersecurity frameworks	20%	60%	85%	100%
Annual cybersecurity audits completed	10%	60%	90%	100%
National research data repository operational	No	Yes	Expanded nationally	Fully integrated with global repositories
Research datasets published annually	500	3,000	8,000	15,000
Institutions implementing FAIR research data standards	10%	40%	75%	100%
Active university–industry digital research partnerships	150	400	800	1,500
Technology Transfer Offices (TTOs) fully operational	25	60	120	200
Annual patents originating from higher education institutions	250	500	1,000	1,500
Annual university spin-off companies created	30	80	180	350
Annual research commercialization revenue	₦10 billion	₦30 billion	₦80 billion	₦200 billion
Competitive international research grants secured annually	US$100 million	US$250 million	US$500 million	US$1 billion
International collaborative research projects	250	500	1,000	2,000
Institutions participating in global research networks	40%	70%	90%	100%
National research performance dashboard operational	No	Yes	Fully integrated	AI-powered predictive analytics
Institutions submitting annual digital research reports	30%	70%	90%	100%
Average research administration processing time	90 days	60 days	30 days	<15 days
Institutions using digital grant management systems	15%	60%	85%	100%

Renewable energy powering research facilities	10%	25%	50%	75%
Green-certified research laboratories	5%	20%	50%	80%
Laboratory hazardous waste safely managed	40%	70%	90%	100%
Regional disparity index in research infrastructure (difference between best- and least-equipped regions)	High	Reduced by 25%	Reduced by 50%	Reduced by 80%
Researchers satisfied with research infrastructure and digital services	40%	60%	80%	95%

Timeline

The implementation of the **Research Infrastructure and Digital Transformation** component will be undertaken over a **10-year period (2026–2035)** through four phases. Each phase builds progressively from policy development and capacity building to nationwide infrastructure modernization, digital transformation, and sustainability (Table 5.11).

Table 5.11: Milestones by Phase for Research Infrastructure and Digital Transformation

Phase	Period	Major Deliverables
Phase I – Foundation and Planning	2026–2027	National research infrastructure audit completed; governance and policy frameworks established; national equipment inventory developed; Open Science Policy approved; RIMS pilots launched; broadband expansion initiated; first cohort of researchers and technical staff trained in digital research skills.
Phase II – Infrastructure Scale-Up	2028–2030	Major laboratory modernization across institutions; regional shared research facilities established; NgREN expanded to most HEIs; institutional repositories operational; AI, HPC, and data science centres established; technology transfer offices strengthened; national research dashboard deployed.
Phase III – National Expansion and Integration	2031–2033	Universal adoption of digital research systems; national research data repository fully operational; university–industry research collaborations expanded; advanced digital research capabilities embedded; increased commercialization, patenting, and international research partnerships.
Phase IV – Sustainability and Global Competitiveness	2034–2035	All higher education institutions meet national infrastructure standards; nationwide digital research ecosystem fully integrated; green laboratories widely adopted; research infrastructure sustainably maintained; Nigeria recognized as a leading African hub for STEM research and innovation.

Expected outcomes

The expected outcomes of the **Research Infrastructure and Digital Transformation** component are organized into four implementation phases to reflect the progressive transformation of Nigeria's higher education research ecosystem. These outcomes align with the strategic goals of strengthening research capacity, accelerating digital transformation, promoting innovation, and enhancing global competitiveness

Phase 1 Outcomes

1. National policy and governance framework for research infrastructure and digital transformation established. Comprehensive national audit of research infrastructure and scientific equipment completed.
2. National inventory of research equipment and facilities developed.
3. Standards and guidelines for research infrastructure, digital systems, and equipment management adopted.
4. Pilot deployment of Research Information Management Systems (RIMS) and institutional digital repositories in selected institutions.
5. Initial expansion of broadband connectivity and integration with the Nigerian Research and Education Network (NgREN), TERAS, BRIDGE. National Open Science Policy and Research Data Management Framework approved.
6. Capacity-building programmes for researchers, laboratory technologists, ICT personnel, and research administrators initiated.
7. National coordination and monitoring mechanisms established

Phase 2 Outcomes

1. Significant modernization of laboratories, workshops, pilot plants, and research facilities across higher education institutions. Regional shared research infrastructure and scientific equipment centres operational.
2. Majority of higher education institutions connected to high-speed broadband and NgREN.
3. Widespread deployment of digital research management systems, institutional repositories, and cloud-based research platforms.
4. AI, high-performance computing (HPC), robotics, GIS, and data science centres established in priority institutions. •
5. Equipment maintenance and calibration systems institutionalized.
6. Technology Transfer Offices (TTOs), innovation hubs, and digital collaboration platforms strengthened.
7. Increased participation in national and international collaborative research projects.
8. National research performance dashboard operational for evidence-based planning and monitoring.

Phase 3 Outcomes

1. Integrated national digital research ecosystem connecting universities, polytechnics, colleges of education, and research institutes established.
2. Universal adoption of digital research administration, electronic laboratory notebooks, and institutional repositories.
3. National research data repository fully operational and aligned with FAIR data principles.
4. Significant increase in high-quality publications, patents, prototypes, and technology commercialization.
5. Strong university–industry–government collaboration driving innovation and applied research.
6. Nigerian researchers increasingly participate in international research consortia and attract competitive research funding.

7. Enhanced cybersecurity and digital governance across all research institutions.
8. Reduced regional disparities in access to research infrastructure and digital resources.]
9. Improved operational efficiency through digital research management and analytics.

Phase 4 Outcomes

1. All higher education institutions meet national minimum standards for research infrastructure and digital readiness. Sustainable financing and maintenance systems for research infrastructure are fully institutionalized.
2. Nigeria recognized as a leading African hub for STEM research, digital innovation, and technology commercialization.
3. Research infrastructure is supported by renewable energy, green laboratories, and sustainable laboratory management practices. Fully integrated national research information system providing real-time data for policy and investment decisions.
4. Nigerian higher education institutions become preferred partners in global research and innovation networks.
5. Increased contribution of research and innovation to industrialization, job creation, economic diversification, and national competitiveness.
6. Strong culture of open science, digital collaboration, and knowledge sharing embedded across the higher education system.
7. A resilient, inclusive, and future-ready research ecosystem capable of responding to emerging scientific, technological, and societal challenges.

5.3 Centres of Excellence, Research Hubs and Research Clusters

Introduction

Centres of Excellence, Research Hubs and Research Clusters are fundamental to achieving Nigeria's vision of a globally competitive, innovation-driven STEM ecosystem. They provide institutional platforms for concentrating scientific expertise, advanced research infrastructure, multidisciplinary collaboration, and sustainable funding around national priority areas. Rather than dispersing scarce resources across numerous institutions, these platforms promote specialization, resource sharing, and collaborative research, enabling universities, polytechnics, colleges of education, research institutes, industry, and government agencies to jointly address complex national development challenges through high-impact science, technology, engineering, and mathematics (STEM) research.[83]

The strategy proposes the establishment and strengthening of nationally coordinated Centres of Excellence, thematic Research Hubs, and interdisciplinary Research Clusters in strategic sectors such as advanced manufacturing, artificial intelligence, biotechnology, renewable energy, climate resilience, agriculture, health, materials science, digital technologies, and the blue economy. These interconnected platforms will enhance postgraduate education, facilitate multidisciplinary and multi-institutional research, improve access to shared research infrastructure, strengthen technology transfer and commercialization, and foster stronger

[83] World Bank (2025). The African Centers of Excellence: 10 Years of Innovation and Impact; Association of African Universities (2025). Africa Higher Education Centres of Excellence (ACE) Impact Project.

partnerships between academia, industry, government, and international collaborators. Such an integrated research ecosystem will significantly improve research productivity, innovation outputs, and national competitiveness.[84]

The proposed component builds upon successful regional initiatives such as the Africa Higher Education Centres of Excellence (ACE) programme, which has demonstrated the effectiveness of concentrating research capacity and regional collaboration in addressing Africa's development challenges. Nigeria has emerged as one of the leading beneficiaries of the ACE initiative, hosting numerous internationally recognized centres that have contributed significantly to postgraduate training, research excellence, innovation, and industry engagement. Lessons from the ACE programme demonstrate that well-governed and adequately funded Centres of Excellence can attract international research funding, produce globally competitive research, strengthen human capital development, and accelerate socio-economic transformation.

Accordingly, this component of the Nigeria STEM Transformation Strategy seeks to establish a coordinated national network of Centres of Excellence, Research Hubs, and Research Clusters that will serve as engines of scientific discovery, innovation, commercialization, talent development, and evidence-based policymaking. Through performance-based funding, strategic governance, digital connectivity, shared research infrastructure, and strong national and international partnerships, these centres will position Nigeria as a leading STEM research and innovation hub in Africa while contributing directly to the country's economic diversification, industrialization, and sustainable development agenda.

Vision

"A connected and internationally competitive ecosystem of Centres of Excellence, Research Hubs, and Research Clusters driving scientific excellence, innovation, and sustainable national development."

Mission

"To strengthen Nigeria's higher education research ecosystem by developing specialized Centres of Excellence, fostering multidisciplinary research hubs and collaborative clusters, expanding access to shared research infrastructure, promoting industry-academia-government partnerships, attracting sustainable investment, and translating scientific discoveries into innovative solutions that address national priorities and enhance global competitiveness."

Strategic Goals

The strategic goals for the **Centres of Excellence, Research Hubs, and Research Clusters** component provide the framework for building a coordinated, high-performing, and globally competitive STEM research ecosystem in Nigeria. They are designed to strengthen institutional capacity, promote research excellence, foster multidisciplinary collaboration, expand access to shared research infrastructure, and accelerate the translation of scientific knowledge into innovative products, services, and policies that address national development priorities. Collectively, these goals support the transformation of Nigeria's higher education institutions into hubs of research excellence, technology development, and knowledge-driven economic

[84] National Universities Commission (2015). African Centres of Excellence (ACE) Project, Nigeria; World Bank (2025). The African Centers of Excellence: 10 Years of Innovation and Impact.

growth while enhancing the country's competitiveness within Africa and the global innovation landscape. The goals as presented in Table 5.12 also align with Nigeria's national development agenda, the African Union's Agenda 2063, the Science, Technology and Innovation Strategy for Africa (STISA-2034), and the Sustainable Development Goals (SDGs), ensuring that investments in research generate measurable social, economic, and environmental impact

Table 5.12: Strategic Goals and Desired Outcomes framework for the Centres of Excellence, Research Hubs and Research Clusters component of the Nigeria's STEM Transformation Strategy for Higher Education

Strategic Goal	Desired Outcomes
1. Establish a nationally coordinated network of Centres of Excellence, Research Hubs, and Research Clusters in priority STEM fields.	Functional network of nationally recognized Centres of Excellence across geopolitical zones. Increased institutional specialization in strategic STEM disciplines. Improved coordination of national research priorities.
2. Strengthen research capacity and scientific excellence across higher education institutions.	Increased quantity and quality of internationally competitive research. Growth in highly skilled researchers, postgraduate students, and technical personnel. Enhanced research leadership and mentorship.
3. Promote multidisciplinary and multi-institutional collaboration among universities, polytechnics, colleges of education, research institutes, industry, and government.	Strong national and regional research partnerships. Increased collaborative research projects and joint publications. Greater sharing of expertise, facilities, and research infrastructure.
4. Develop shared research infrastructure and digital research platforms to maximize resource utilization.	Increased access to advanced laboratories, equipment, high-performance computing, and digital repositories. Reduced duplication of expensive research facilities. Higher utilization rates of national research infrastructure.
5. Increase research commercialization, technology transfer, and innovation-driven entrepreneurship.	Increased patents, prototypes, licenses, spin-off companies, and start-ups. Stronger university-industry collaboration. Higher contribution of research to economic growth and industrial competitiveness.
6. Attract sustainable research funding and strategic national and international partnerships.	Increased competitive research grants from government, industry, development partners, and international agencies. Diversified funding sources. Improved financial sustainability of research centres.
7. Address national development priorities through mission-oriented research in strategic sectors.	Research solutions supporting food security, healthcare, energy transition, climate resilience, manufacturing, digital economy, education, and national security. Greater uptake of research outputs in policy and industry.
8. Strengthen postgraduate education, researcher mobility, and talent development.	Increased enrolment and graduation of MSc, PhD, and postdoctoral researchers. Improved supervision quality. Enhanced national and international researcher exchange programmes.
9. Enhance international visibility, global competitiveness, and research impact of Nigerian institutions.	Improved international university and research rankings. Increased citation impact and global collaborations. Greater participation in international research consortia and flagship programmes.
10. Establish effective governance, performance management, and quality assurance systems for Centres of Excellence, Research Hubs, and Research Clusters.	Transparent governance and accountability frameworks. Performance-based funding and monitoring systems. Regular evaluation of research impact and institutional performance. Long-term sustainability of centres and research networks.

Strategic Activities

The successful implementation of the **Centres of Excellence, Research Hubs, and Research Clusters** component requires a coordinated portfolio of strategic activities and targeted programmes that translate the strategic goals into measurable actions. These activities are designed to strengthen institutional research capacity, establish and operationalize specialized centres and collaborative research networks, expand access to world-class research infrastructure, promote multidisciplinary partnerships, and enhance the commercialization of research and innovation. The programmes also seek to foster stronger linkages among higher education institutions, research institutes, industry, government, and international partners, creating an integrated national research ecosystem capable of addressing Nigeria's priority development challenges. Together, these activities and programmes (Table 5.13) provide a practical implementation framework for building sustainable, high-performing research institutions that drive scientific excellence, technological advancement, human capital development, and socio-economic transformation in line with Nigeria's STEM Transformation Strategy.

Table 5.13: Activities and Programmes for the expansion of Centres of Excellence, Research Hubs and Research Clusters component in the Nigeria's STEM transformation strategy for Higher Education

Goals	Activities	Programmes/Initiatives	Key Performance Indicators (KPIs)
1	Identify priority STEM thematic areas; establish new centre, research hubs and clusters. Accredit existing centres; develop governance framework	National STEM Centres of Excellence Programme; National Research Hub Initiative; Research Cluster Development Programme; National competitive grant scheme	Number of Centres of Excellence established Number of Research Hubs operational. Number of Research Clusters formed Percentage of geopolitical zones with at least one Centre of Excellence
2	Recruit and retain researchers; provide research grants; develop mentoring programmes; strengthen postgraduate training	National Research Capacity Development Programme; Early Career Research Fellowship; Research Leadership Academy	Number of researchers trained. Number of postgraduate students supported. Number of competitive research grants awarded. Publications in indexed journals Citation impact
3	Develop collaborative research networks; facilitate joint projects; establish inter-institutional agreements	National Collaborative Research Network; Inter-University Research Consortium Programme	Number of collaborative projects. Number of institutions participating. Joint publications. Joint grant applications submitted
4	Establish shared laboratories; procure advanced equipment; develop national equipment database; implement digital collaboration platforms	Shared Research Infrastructure Programme; National Research Equipment Sharing Platform; Digital Research Collaboration Network	Number of shared. laboratories established Equipment utilization rate (%). Number of institutions accessing shared facilities. Operational national equipment inventory
5	Establish technology transfer offices; support patenting; incubate start-	Innovation and Commercialization Programme; University Innovation	Patents filed and granted. Licences executed. Start-ups/spin-offs created. Industry-

	ups; strengthen industry engagement	Hubs; Technology Transfer and IP Programme	funded research projects. Commercialized technologies
6	Develop partnership frameworks; organize industry forums; establish international collaborations	Triple Helix Partnership Initiative; Global Research Partnership Programme; Industry Research Partnership Scheme	Number of MoUs signed Industry investment in research. International collaborative projects External funding mobilized
7	Launch challenge-driven research calls; support interdisciplinary research teams; monitor societal impact	National Grand Challenges Research Programme; Mission-Oriented Innovation Programme	Number of national challenge projects funded. Research outputs adopted by government or industry. Societal impact case studies. Policy briefs produced
8	Provide scholarships; establish exchange programmes; support postdoctoral fellowships	National STEM Graduate Scholarship Programme; Researcher Mobility Scheme; Postdoctoral Fellowship Programme	MSc and PhD enrolment. PhD completion rate. Number of researchers exchanges Postdoctoral fellows supported
9	Support participation in global research networks; improve research quality; promote international accreditation	Global Research Excellence Programme; International Benchmarking Initiative	International university rankings. Highly cited publications. International research collaborations Global awards and recognitions
10	Develop governance guidelines; implement performance-based funding; establish M&E framework; conduct periodic evaluations	National Research Governance Programme; Performance-Based Funding Initiative; Research Excellence Assessment Framework	Governance framework implemented. Annual performance reviews completed• Centres meeting performance targets (%). Sustainable funding secured

Responsibilities

Successful implementation of the **Centres of Excellence, Research Hubs, and Research Clusters** component requires coordinated action across government ministries, regulatory agencies, higher education institutions, research institutes, industry, development partners, and the private sector. The responsibility matrix in Table 5.14aa and 7.12b identifies the lead and supporting institutions responsible for delivering each strategic activity, ensuring clear accountability, effective coordination, and efficient use of resources.

Table 5.14a: Implementation Responsibility Matrix for centres of excellence, research hubs and research clusters

Strategic Activity	**Lead Responsibility**	**Supporting Institutions/Partners**
Develop national policy and governance framework for Centres of Excellence, Research Hubs and Research Clusters	Federal Ministry of Education (FME)	National Universities Commission (NUC), National Board for Technical Education (NBTE), National Commission for Colleges of Education (NCCE), Federal Ministry of Innovation, Science and Technology (FMIST), Tertiary Education Trust Fund (TETFund), National Planning Commission, State Ministries of Education
Identify priority research themes and designate Centres of Excellence	FME, NUC	NBTE, NCCE, FMIST, TETFund, National Research Fund (NRF), Academia, Industry

Establish and strengthen Centres of Excellence	TETFund	Universities, Polytechnics, Colleges of Education, Research Institutes, State Governments, Development Partners
Establish thematic Research Hubs and interdisciplinary Research Clusters	NUC, NBTE, NCCE	Universities, Polytechnics, Colleges of Education, Research Institutes, Professional Associations
Develop shared research infrastructure and national equipment-sharing systems	TETFund	FMIST, NUC, NBTE, NCCE, Nigerian Research and Education Network (NgREN), Higher Education Institutions (HEIs), Research Institutes
Establish national digital collaboration platforms and research repositories	NgREN	National Information Technology Development Agency (NITDA), Galaxy Backbone, NUC, TETFund, Universities, Research Institutes
Build research capacity through postgraduate training, fellowships and mentorship	Universities	TETFund, NUC, NBTE, NCCE, Research Institutes, International Partners
Promote multidisciplinary and multi-institutional collaborative research	NUC	Universities, Polytechnics, Colleges of Education, Research Institutes, Industry Associations, Development Partners
Promote technology transfer, commercialization and innovation	FMIST	National Office for Technology Acquisition and Promotion (NOTAP), TETFund, Universities, Technology Transfer Offices (TTOs), Industry
Strengthen university-industry-government partnerships	FME	Manufacturers Association of Nigeria (MAN), Nigerian Economic Summit Group (NESG), Chambers of Commerce, Private Sector, Development Partners
Mobilize national and international research funding	TETFund	Federal Ministry of Finance, Development Partners, Philanthropic Foundations, Industry, International Funding Agencies
Support international collaborations and researcher mobility	NUC	Federal Ministry of Foreign Affairs, Universities, African Centres of Excellence, African Union, UNESCO, International Universities
Develop national research monitoring, evaluation and performance management system	FME	NUC, NBTE, NCCE, TETFund, National Bureau of Statistics (NBS), FMIST
Conduct periodic impact assessment and institutional accreditation	NUC	NBTE, NCCE, TETFund, Independent Quality Assurance Agencies
Ensure sustainability through performance-based funding and continuous improvement	FME	Federal Ministry of Finance, Budget Office, TETFund, NUC, State Governments, Development Partners

Table 5.14b: Institutional Roles for centres of excellence, research hubs and research clusters

Institution	Primary Role
Federal Ministry of Education (FME)	Overall policy leadership, coordination, oversight, and inter-ministerial collaboration.
National Universities Commission (NUC)	Regulation, accreditation, quality assurance, and coordination of universities and Centres of Excellence.
National Board for Technical Education (NBTE)	Coordination of polytechnics and technical institutions participating in research hubs and clusters.
National Commission for Colleges of Education (NCCE)	Integration of Colleges of Education into STEM research, teacher education research, and innovation networks.
Tertiary Education Trust Fund (TETFund)	Primary funding agency for research infrastructure, competitive grants, Centres of Excellence, and capacity development.
Federal Ministry of Innovation, Science and Technology (FMIST)	National science, technology, innovation, commercialization, and research policy coordination.
National Information Technology Development Agency (NITDA)	Development of digital research infrastructure, cybersecurity, digital platforms, and research data governance.
NgREN	Provision of high-speed research connectivity, digital collaboration services, cloud infrastructure, and national research repositories.
Higher Education Institutions (Universities, Polytechnics, Colleges of Education)	Host and manage Centres of Excellence, conduct research, train researchers, and foster innovation.
Research Institutes	Provide specialized expertise, advanced facilities, and collaborative research programmes aligned with national priorities.
Industry and Private Sector	Co-fund research, define industry priorities, provide commercialization pathways, internships, and innovation partnerships.
Development Partners and International Organizations	Technical assistance, capacity building, international collaboration, research funding, and knowledge exchange.
State Governments	Co-invest in regional Centres of Excellence, provide enabling policies, and support local innovation ecosystems.

Key Performance Indicators

The successful implementation of the **Centres of Excellence, Research Hubs, and Research Clusters** component will be measured through a comprehensive set of Key Performance Indicators (KPIs) that assess progress, performance, and impact over the short, medium, and long term. These indicators provide a results-based monitoring and evaluation framework for tracking the establishment and effectiveness of research centres, the quality and impact of research outputs, collaboration among institutions, utilization of research infrastructure, innovation and commercialization outcomes, human capital development, and the contribution of research to national development. The KPIs are designed to support evidence-based decision-making, promote accountability, guide performance-based funding, and enable continuous improvement throughout the implementation of the STEM Transformation Strategy. Baseline values is established through a national assessment, while phased targets

will provide measurable milestones for evaluating progress towards building a globally competitive and sustainable STEM research ecosystem in Nigeria.

Table 5.15: Key Performance Indicators (KPIs) framework for the Centres of Excellence, Research Hubs and Research Clusters

Key Performance Indicator	Baseline (2026)	Short-Term Target (2027–2029)	Medium-Term Target (2030–2033)	Long-Term Target (2034–2036)
National policy and governance framework for Centres of Excellence approved	Fragmented institutional frameworks	National framework approved and implementation commenced	Fully operational across all federal institutions	Regularly reviewed and adopted nationwide
National Centres of Excellence established/strengthened	Existing centres operating independently	At least **20** nationally designated Centres of Excellence	**40** Centres of Excellence operational	**60+** internationally competitive Centres of Excellence
Thematic Research Hubs established	Few formal hubs	**25** Research Hubs established	**60** operational hubs	**100** nationally coordinated Research Hubs
Interdisciplinary Research Clusters established	Limited collaboration	**100** research clusters	**250** research clusters	**500** active research clusters
Higher Education Institutions participating in research networks	<30%	50% of HEIs	80% of HEIs	100% of eligible HEIs
Shared national research laboratories established	Limited shared facilities	15 shared laboratories	35 shared laboratories	60 shared laboratories
National research equipment-sharing platform operational	No integrated national platform	Platform established with 200 institutions	500 institutions connected	All public HEIs and research institutes connected
Research equipment utilization rate	Approximately 40%	60%	80%	>90%
Competitive research grants awarded annually	Limited national competitive grants	300 grants/year	700 grants/year	1,200 grants/year
External research funding mobilized	Low international funding	US$200 million cumulative	US$750 million cumulative	US$2 billion cumulative
Peer-reviewed publications (Scopus/Web of Science)	Current national output	50% increase	150% increase	300% increase
Average field-weighted citation impact	Below global average	0.9	1.1	≥1.5
Patents filed annually	Limited patent activity	250 patents/year	600 patents/year	1,000 patents/year
Technologies commercialized	Few technologies reach market	50 technologies	150 technologies	300 technologies
University spin-offs/start-ups created	Limited	100 start-ups	300 start-ups	700 start-ups
Industry-funded research projects	Low industry participation	150 projects	400 projects	800 projects
Active university-industry partnership agreements	Limited	200 agreements	500 agreements	1,000 agreements

MSc and PhD graduates supported through Centres	Existing institutional programmes	5,000 graduates	15,000 graduates	30,000 graduates
Postdoctoral fellows supported	Very limited	500 fellows	1,500 fellows	3,000 fellows
Researchers completing international exchange programmes	Limited	1,000 researchers	3,000 researchers	6,000 researchers
Female participation in research leadership	Approximately 20%	30%	40%	≥50%
International collaborative research projects	Limited	150 projects	400 projects	800 projects
Internationally accredited Centres of Excellence	Few	10 centres	25 centres	50 centres
Research outputs informing public policy	Ad hoc	50 policy briefs adopted	150 policy interventions	300 evidence-based policy interventions
Graduate employability in STEM research and innovation sectors	Approximately 60%	70%	80%	>90%
Jobs created through research commercialization	Limited	5,000 jobs	20,000 jobs	50,000 jobs
Contribution of research and innovation to GDP	Low contribution	Measurable increase established	Significant contribution to industrial growth	Research and innovation become a major driver of the knowledge economy
Annual performance evaluation of Centres completed	No standardized system	Annual national assessment implemented	Performance-based funding institutionalized	Continuous benchmarking against global standards

Timeline

The implementation of the **Centres of Excellence, Research Hubs, and Research Clusters** component will be undertaken through a phased approach over a **10-year period (2027–2036)** to ensure systematic planning, sustainable investment, institutional capacity development, and measurable impact. The phased implementation allows for the progressive establishment of governance structures, research infrastructure, collaborative networks, and innovation ecosystems while providing opportunities for continuous monitoring, evaluation, and refinement. The timeline is designed to align with the broader implementation framework of Nigeria's STEM Transformation Strategy for Higher Education and to ensure that short-term achievements create the foundation for medium- and long-term transformation.

Table 5.16: Implementation Timeline (2027–2036)

Strategic Activity	Phase I (2027–2029) Foundation & Establishment	Phase II (2030–2033) Expansion & Consolidation	Phase III (2034–2036) Sustainability & Global Competitiveness
Develop national policy and governance framework	✓	Review	Periodic review
Establish new Centres of Excellence	✓	✓	✓
Establish thematic Research Hubs	✓	✓	Expansion
Develop interdisciplinary Research Clusters	✓	✓	Expansion
Upgrade shared laboratories and research infrastructure	✓	✓	Continuous modernization
Develop national research equipment-sharing platform	✓	Expansion	Optimization
Establish digital research collaboration platforms	✓	Enhancement	Continuous improvement
Procure advanced scientific equipment	✓	✓	Upgrading and replacement
Recruit and train researchers and technical personnel	✓	✓	Continuous professional development
Expand postgraduate scholarships and fellowships	✓	✓	✓
Promote multidisciplinary collaborative research	✓	✓	✓
Strengthen university–industry partnerships	✓	✓	Expansion
Promote technology transfer and commercialization	Pilot	Scale-up	Full implementation
Establish innovation hubs and incubators	✓	Expansion	National coverage
Mobilize national and international research funding	✓	✓	Diversification of funding sources
Support international research collaborations	✓	✓	Global leadership
Implement monitoring, evaluation, and performance management	✓	✓	Continuous improvement
Conduct impact assessments and external evaluations	Baseline & Mid-term	Mid-term Review	Final Evaluation
Introduce performance-based funding	Design & Pilot	Full implementation	Continuous optimization
Benchmark against global Centres of Excellence	Planning	Regional benchmarking	Global benchmarking

Expected outcomes

The implementation of the **Centres of Excellence, Research Hubs, and Research Clusters** component is expected to transform Nigeria's higher education research ecosystem into a coordinated, innovation-driven, and globally competitive system that supports scientific excellence, technological advancement, and national development as presented in Table 5.17.

Table 5.17: Expected outcomes from each implementation phase

Implementation Phase	Expected Outcomes
Phase I (2027–2029): Foundation and Establishment	National governance framework established; first cohort of Centres of Excellence and Research Hubs designated; research infrastructure upgraded; national equipment-sharing platform launched; collaborative research networks initiated; baseline performance assessment completed.
Phase II (2030–2033): Expansion and Consolidation	Expansion of Centres of Excellence and Research Clusters nationwide; increased research funding and international partnerships; strengthened postgraduate training; significant growth in publications, patents, commercialization, and industry collaboration; performance-based funding fully operational.
Phase III (2034–2036): Sustainability and Global Competitiveness	Internationally recognized Centres of Excellence; sustainable research financing; globally competitive research outputs; mature innovation and commercialization ecosystem; strong contribution of STEM research to industrialization, economic diversification, and evidence-based policymaking; continuous benchmarking against global best practices.

Long-Term Transformational Outcomes

By the end of the implementation period, the strategy is expected to deliver the following transformational outcomes:

1. A nationally integrated and internationally recognized network of Centres of Excellence, Research Hubs, and Research Clusters.
2. A robust, well-funded, and sustainable STEM research ecosystem that supports world-class scientific discovery and innovation.
3. Increased research productivity, citation impact, patents, technology commercialization, and knowledge transfer.
4. Stronger collaboration among universities, polytechnics, colleges of education, research institutes, industry, government, and international partners.
5. Modern, shared research infrastructure that maximizes resource utilization and reduces duplication of investment.
6. A highly skilled pipeline of researchers, innovators, entrepreneurs, and STEM professionals capable of driving Nigeria's industrial and technological development.
7. Greater contribution of research and innovation to economic diversification, job creation, improved productivity, and national competitiveness.
8. Increased use of evidence-based research in policymaking and national development planning.
9. Improved resilience of Nigeria's higher education system through sustainable governance, performance-based funding, and continuous quality improvement.
10. A globally competitive research and innovation ecosystem that positions Nigeria as a leader in STEM education, research, and innovation in Africa and contributes significantly to the achievement of the Sustainable Development Goals (SDGs), the

African Union Agenda 2063, and Nigeria's long-term national development aspirations.

5.4 Innovation, Entrepreneurship and Industry Linkages

Introduction

Innovation, entrepreneurship, and industry linkages are essential pillars of a globally competitive STEM ecosystem and are increasingly recognized as key drivers of economic diversification, industrial competitiveness, job creation, and sustainable national development. While Nigeria has made significant investments in expanding access to higher education and increasing research output, the translation of research findings into commercially viable products, services, and technologies remains limited. Weak collaboration between universities, industry, government, and investors has resulted in low levels of technology commercialization, inadequate patenting, limited startup creation, and insufficient contribution of research to national productivity (World Bank, 2024; UNESCO, 2020).[85] Nigeria's innovation and entrepreneurship ecosystem is at a transitional stage, while the country has demonstrated strong potential through its digital startup growth and youthful population, significant gaps remain in research commercialization, university-industry collaboration, innovation financing, and STEM-driven industrialization.

Innovation in Nigeria

Nigeria's innovation ecosystem has expanded significantly over the past decade, especially in FinTech, Digital technologies, E-commerce, AI, AgriTech, HealthTech and Renewable energy innovation Nigeria is now regarded as one of Africa's leading startup ecosystems, particularly in cities such as Lagos, Abuja, Port Harcourt, Enugu and Ibadan. Technology startups such as: Flutterwave, Paystack, Andela, Moniepoint, and Interswitch have demonstrated the country's innovation potential. However, innovation activities remain concentrated in the private digital sector, while university-led innovation and industrial research commercialization remain weak. Research institutions still contribute minimally to industrial productivity and national manufacturing transformation. The Federal Government has attempted to address this through policy reforms such as the National Science, Technology and Innovation Policy (NSTIP), Nigeria Startup Act, National Digital Economy Policy and National Development Plan (2021–2025). These policies aim to strengthen Nigeria's National Innovation System and promote a knowledge-based economy (Federal Ministry of Science, Technology and Innovation, 2022).[86]

Entrepreneurship Development in Nigeria

Entrepreneurship has become increasingly important due to High youth unemployment, Graduate underemployment, Economic diversification needs and Rapid digital transformation. Many Nigerian higher institutions now offer entrepreneurship education as part of undergraduate training. Entrepreneurship Development Centres (EDCs) have also been

[85] World Bank (2024). Accelerating Innovation for Development: How Universities Leverage Knowledge Exchange to Boost Economic Growth in Middle-Income Countries; UNESCO. (2020). Global Education Monitoring Report 2020: Inclusion and Education. UNESCO Publishing

[86] Federal Ministry of Science, Technology and Innovation. (2022). National Science, Technology and Innovation Policy (NSTIP). Government of Nigeria.

established in several institutions. Despite this progress, entrepreneurship education in Nigeria is still largely theoretical rather than innovation-driven. Many institutions lack:

1. Startup incubation facilities
2. Prototype laboratories
3. Venture funding mechanisms
4. Technology commercialization systems
5. Industry mentorship structures

Studies show that while entrepreneurship education is expanding across the Global South, including Nigeria, major challenges remain in integrating entrepreneurship into STEM curricula due to inadequate infrastructure, weak industry partnerships, and limited funding (Mapanga, 2025).[87] Furthermore, many graduates still lack practical innovation and enterprise creation skills needed for technology-driven industries (Adesina and Obokoh, 2026).[88]

Academia-Industry Linkages

University-industry collaboration in Nigeria remains relatively weak and underdeveloped compared to advanced innovation economies. Most existing collaborations are limited to:

1. Student industrial attachments (SIWES)
2. Internship placements
3. Occasional consultancy services
4. Limited sponsored research

Research indicates that only a small proportion of collaborations focus on solving industrial problems or developing commercially viable technologies (Abonyi and Nwadike, 2025).[89]

The Nigeria STEM Transformation Strategy for Higher Education therefore is to position innovation and entrepreneurship as core functions of higher education institutions alongside teaching and research. Universities, polytechnics, colleges of education and research institutes to evolve into entrepreneurial institutions that not only generate knowledge but also transform scientific discoveries into market-ready innovations through technology transfer, intellectual property management, startup incubation, business acceleration, and strategic partnerships with industry. This transformation requires a shift from isolated academic research towards demand-driven, multidisciplinary, and collaborative innovation that addresses national priorities in agriculture, health, manufacturing, energy, digital technology, climate resilience, and the green economy.

This component of the STEM Transformation Strategy seeks to establish an integrated national innovation ecosystem by strengthening university-industry partnerships, promoting entrepreneurship across all STEM disciplines, supporting technology transfer offices and innovation hubs, expanding access to venture financing, and creating enabling policies for

[87] Mapanga, A., & Faleni, N. (2025). Integrating entrepreneurship education into STEM curricula in global South higher education institutions. Discover Education. https://doi.org/10.1007/s44217-025-00798-8
[88] Adesina, O. S., & Obokoh, L. O. (2026). STEM education leadership and industry partnerships: Bridging the gap between educational institutions and industry. STEM Education, 6(2), 258–283. https://doi.org/10.3934/steme.2026011
[89] Abonyi, D. O., & Nwadike, I. M. (2025). Exploring university-industry collaboration for technological innovation in Nigeria. Scientific Culture Journal, 4(1).

commercialization of research outputs. It also aims to foster collaboration among academia, government, industry, investors, and development partners to ensure that STEM education and research become engines of economic growth, industrial transformation, and sustainable development in Nigeria. By embedding innovation and entrepreneurship throughout the higher education system, Nigeria can develop a new generation of scientists, engineers, technologists, and entrepreneurs capable of transforming research into impactful solutions that address national and global challenges.

Vision

"A dynamic Nigerian higher education system where STEM innovation drives industrial transformation, entrepreneurship, and sustainable economic prosperity."

Mission

"To empower higher education institutions to become engines of innovation through strategic industry partnerships, entrepreneurship education, technology transfer, and commercialization of research that creates jobs, attracts investment, and addresses national development challenges."

Strategic Goals

The **Innovation, Entrepreneurship and Industry Linkages** component of the Nigeria STEM Transformation Strategy seeks to reposition higher education institutions as engines of innovation, technology commercialization, enterprise creation, and industrial development. The strategic goals are designed to strengthen collaboration among academia, industry, government, investors, and development partners while fostering an entrepreneurial culture that transforms STEM research into products, services, jobs, and economic value.

Table 5.18: Strategic goals for Transformation of Innovation, Entrepreneurship and industry linkages in Higher Education in Nigeria

Strategic Goal	Desired Outcomes
1. Strengthen University–Industry Collaboration	Robust partnerships between higher education institutions and industry resulting in collaborative research, industrial problem-solving, curriculum co-development, internships, staff exchanges, and increased private-sector investment in STEM research.
2. Promote Innovation and Commercialization of Research	Increased conversion of research outputs into patents, prototypes, licenses, spin-off companies, and market-ready technologies that address national development priorities.
3. Build Entrepreneurial Capacity among Students and Researchers	STEM graduates, researchers, and faculty equipped with entrepreneurial, business development, innovation management, and leadership skills, leading to increased startup creation and self-employment.
4. Establish Innovation Ecosystems in Higher Education Institutions	Functional innovation hubs, incubation centres, accelerators, makerspaces, fabrication laboratories (FabLabs), and technology parks established across universities, polytechnics, and colleges of education.
5. Strengthen Intellectual Property (IP) Management and Technology Transfer	Efficient institutional IP policies, Technology Transfer Offices (TTOs), and licensing frameworks that protect innovations and facilitate commercialization of research outputs.
6. Expand Access to Innovation Financing and Venture Support	Improved access to seed funding, venture capital, angel investment, innovation grants, and commercialization funds for researchers, startups, and student entrepreneurs.

7. Foster Industry-Relevant STEM Education and Workforce Development	STEM curricula aligned with labour market needs, producing graduates with technical, entrepreneurial, digital, and innovation competencies required by industry.
8. Promote Regional and International Innovation Partnerships	Increased collaboration with global universities, research institutes, multinational industries, innovation networks, and development partners to enhance technology transfer and research commercialization.
9. Strengthen Policy, Governance, and Regulatory Frameworks for Innovation	Harmonized national policies supporting innovation, entrepreneurship, intellectual property protection, startup development, and university-industry collaboration, with improved institutional governance and accountability.
10. Drive Inclusive and Sustainable Innovation for National Development	Greater participation of women, youth, persons with disabilities, and underserved regions in STEM innovation and entrepreneurship, leading to inclusive economic growth, green technologies, and sustainable development.

Strategic Activities

Achieving the strategic goals of **Innovation, Entrepreneurship and Industry Linkages** component requires coordinated investments in institutional capacity, innovation infrastructure, industry collaboration, technology commercialization, entrepreneurship development, and enabling policy reforms. The activities and programmes outlined in Table 7.17 are aligned with Nigeria's **National Development Plan (2021–2025)**, the **Nigeria Startup Act (2022)**, the **National Policy on Science, Technology and Innovation (2022)**, the **African Union STISA-2034**, and international best practices recommended by UNESCO and the World Bank. Together, these interventions will strengthen the national innovation ecosystem, increase commercialization of research outputs, improve graduate employability, and position higher education institutions as catalysts for industrial transformation and sustainable economic growth. Cross-Cutting National Programmes are presented in Table 5.21

Table 5.19: Strategic Activities and Programmes to accelerate innovation, Entrepreneurship and industry in Higer Education in Nigeria

Strategic Goal Number	Activities	Programmes	Key Performance Indicators (KPIs)
1	Develop institutional partnership frameworks; establish Industry Advisory Boards in higher institutions; facilitate collaborative research and industrial placements	University–Industry Partnership Programme; Industrial Research Collaboration Scheme; National Industry Advisory Council	Number of active industry partnerships; joint research projects; internship placements; industry-funded research value; employer satisfaction rate
2	Support prototype development; establish commercialization pathways; organize innovation fairs; provide proof-of-concept funding	National Research Commercialization Programme; Prototype Development Fund; Annual National Innovation Expo; National digital innovation labs; Innovation sandbox programme, digital skills acceleration programme	Patents filed and granted; prototypes developed; technologies commercialized; licensing agreements signed; commercialization revenue generated
3	Integrate entrepreneurship into STEM curricula; deliver business incubation training; provide mentorship and startup coaching	STEM Entrepreneurship Development Programme; Student Innovation Challenge; Faculty Entrepreneurship Academy	Students trained; faculty trained; startups established; entrepreneurship courses

			introduced; graduate self-employment rate
4	Create innovation hubs, makerspaces, FabLabs, incubators and technology parks; upgrade innovation infrastructure	National Innovation Hub Initiative; Smart Campus Innovation Programme; University Technology Parks Initiative	Innovation hubs established; incubators operational; startups incubated; utilization rate of innovation facilities
5	Establish Technology Transfer Offices (TTOs); Industry partnership offices develop IP policies; train researchers in IP management; streamline patent support	National Technology Transfer Programme; Institutional IP Strengthening Initiative	Institutions with TTOs; IP policies approved; patents protected; licensing agreements executed; technology transfer income
6	Establish seed funding mechanisms; mobilize venture capital; support startup financing; connect innovators with investors	National STEM Innovation Fund; University Venture Fund; Investor–Innovation Matching Platform; Innovation grants	Value of innovation funding mobilized; startups financed; venture capital investments; innovation grants awarded
7	Review curricula jointly with industry; expand internships, apprenticeships and work-based learning; certify industry skills; mandatory Industry Immersion schemes	Industry-Integrated Curriculum Programme; National STEM Apprenticeship Scheme; Graduate Employability Initiative	Curricula revised; internship completion rates; graduate employment rate; employer satisfaction; industry certifications obtained
8	Develop international research and innovation partnerships; facilitate exchange programmes; participate in global innovation networks	Global Innovation Partnership Programme; International Research Mobility Scheme	International partnerships established; joint publications; collaborative innovation projects; international commercialization agreements
9	Develop institutional innovation policies; establish innovation governance structures; strengthen monitoring and evaluation systems	Innovation Governance Strengthening Programme; National Innovation Policy Implementation Support	Institutions with innovation policies; governance structures operational; annual innovation reports; policy compliance rate
10	Support women and youth innovators; establish regional innovation centres; promote green technologies and social innovation	Women in STEM Innovation Programme; Youth Innovation Accelerator; Green Innovation Initiative	Female participation rate; youth-led startups; regional innovation centres established; green technologies developed; social innovation projects supported

Table 5.20: Cross-Cutting National Programmes to accelerate innovation, Entrepreneurship and industry in Higer Education in Nigeria

Programme	Purpose	Lead Institutions
National University Innovation and Entrepreneurship Initiative (NUIEI)	Institutionalize innovation and entrepreneurship across all higher education institutions	Federal Ministry of Education (FME), National Universities Commission (NUC), National Board for Technical Education (NBTE), National Commission for Colleges of Education (NCCE)
National STEM Startup Accelerator	Support commercialization of university innovations and startup growth	FME, Tertiary Education Trust Fund (TETFund), Bank of Industry, private investors
National Technology Transfer Network	Connect higher education institutions with industry for technology licensing and commercialization	FME, National Office for Technology Acquisition and Promotion (NOTAP), NUC
National Innovation Challenge Fund; National Research commercialisation Fund	Provide competitive grants for multidisciplinary STEM innovation projects	TETFund, Federal Ministry of Innovation, Science and Technology, development partners
Industry Fellowship and Staff Exchange Programme. Entrepreneur-in-Residence Programme	Facilitate exchange of researchers and industry professionals	FME, NUC, NBTE, industries
National Innovation and Patent Support Programme	Increase patenting and intellectual property protection	NOTAP, Nigerian Copyright Commission, universities
National Graduate Innovation and Enterprise Programme	Develop entrepreneurial graduates through experiential learning	Higher education institutions, industry associations
National STEM Venture Capital Platform	Link investors with higher education startups and innovation hubs	Nigeria Sovereign Investment Authority, Bank of Industry, private venture capital firms

Responsibilities

Successful implementation of the **Innovation, Entrepreneurship and Industry Linkages** component requires a coordinated, multi-stakeholder approach involving government ministries, regulatory agencies, higher education institutions, industry, development partners, financial institutions, and the private sector. The **Federal Ministry of Education (FME)** should provide overall policy leadership, while implementation should be coordinated through the **National Universities Commission (NUC)**, **National Board for Technical Education (NBTE)**, **National Commission for Colleges of Education (NCCE)**, and other relevant agencies. Strong collaboration with the **Federal Ministry of Innovation, Science and Technology (FMIST)**, **National Office for Technology Acquisition and Promotion (NOTAP)**, **Tertiary Education Trust Fund (TETFund)**, industry associations, venture capital firms, and development partners will be critical to creating a vibrant innovation ecosystem that transforms research into economic and societal impact. The responsibility matrix is presented in Table 5.21.

Table 5.21: Implementation Responsibility Matrix to accelerate innovation, Entrepreneurship and industry in Higer Education in Nigeria

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level
Develop national policy for innovation and entrepreneurship in higher education	Federal Ministry of Education (FME)	FMIST, NUC, NBTE, NCCE, TETFund	National
Mainstream entrepreneurship across STEM curricula	NUC, NBTE, NCCE	HEIs, Industry Advisory Boards, Professional Bodies	National/Institutional
Establish Innovation and Entrepreneurship Centres in all HEIs	TETFund	HEIs, FME, State Governments, Development Partners	Institutional
Establish Technology Transfer Offices (TTOs)	NOTAP	Universities, Polytechnics, Colleges of Education, TETFund	Institutional
Develop institutional Intellectual Property (IP) policies	NOTAP	HEIs, FMIST, Legal Units	Institutional
Create Innovation Hubs, FabLabs and Makerspaces	TETFund	HEIs, Private Sector, Development Partners	Institutional
Develop Technology Parks around selected universities	FME, FMIST	State Governments, Private Investors, Infrastructure Agencies	National/Regional
Promote university–industry collaborative research	TETFund	Industry Associations, HEIs, Research Institutes	National/Institutional
Coordinate industrial internships and apprenticeships	NUC, NBTE, NCCE	Manufacturers Association of Nigeria (MAN), Nigerian Association of Small and Medium Enterprises (NASME), Employers	National
Support prototype development and commercialization	TETFund	NOTAP, Industry Partners, Innovation Hubs	Institutional
Establish National STEM Startup Accelerator Programme	FME	TETFund, Bank of Industry (BOI), Nigeria Sovereign Investment Authority (NSIA), Venture Capital Firms	National
Create Innovation Challenge Grants	TETFund	Development Partners, Private Sector	National
Facilitate access to venture capital and angel investment	BOI	NSIA, Venture Capital Firms, Banks, Development Partners	National
Organize annual National Innovation and Entrepreneurship Competition	FME	NUC, NBTE, NCCE, TETFund, Private Sector	National
Organize National Research Commercialization Expo	FMIST	NOTAP, FME, HEIs, Industry	National
Establish Industry Advisory Boards in all HEIs	HEIs	Industry Associations, NUC, NBTE, NCCE	Institutional
Develop graduate entrepreneurship and incubation programmes	HEIs	Small and Medium Enterprises Development Agency of Nigeria (SMEDAN), BOI, Private Sector	Institutional

Promote women and youth innovation programmes	FME	Federal Ministry of Women Affairs, TETFund, Development Partners	National
Establish regional Centres of Innovation Excellence	FME	State Governments, TETFund, FMIST	Regional
Promote international innovation partnerships	FME	FMIST, HEIs, International Universities, Development Partners	National
Strengthen innovation governance and monitoring systems	FME	NUC, NBTE, NCCE, TETFund	National

Key Performance Indicators

The Key Performance Indicators (KPIs) (Table 5.22) for the **Innovation, Entrepreneurship and Industry Linkages** component are designed to monitor progress toward building a vibrant innovation ecosystem within Nigeria's higher education system. The indicators measure improvements in research commercialization, university-industry collaboration, entrepreneurship development, intellectual property generation, startup creation, innovation financing, and graduate employability. The targets are phased into **Baseline (2026)**, **Short-term (2027–2029)**, **Medium-term (2030–2032)**, and **Long-term (2033–2035)** to support effective monitoring, evaluation, and adaptive management. The targets assume nationwide implementation across universities, polytechnics, and colleges of education and should be refined following a national baseline assessment.

Table 5.22: Key Performance Indicators (KPIs) for the Innovation, Entrepreneurship and Industry Linkages

KPI	Baseline (2026)	Short-Term Target (2027–2029)	Medium-Term Target (2030–2032)	Long-Term Target (2033–2035)
HEIs with approved Innovation & Entrepreneurship Policy	20%	60%	90%	100%
HEIs with functional Innovation and Entrepreneurship Centres	30	120	220	All HEIs
HEIs with Technology Transfer Offices (TTOs) and Industry Partnership offices	15	80	180	All universities and major polytechnics
HEIs with approved Intellectual Property (IP) Policy	15%	60%	90%	100%
Innovation hubs, FabLabs and makerspaces established	40	120	220	300+
Functional university technology parks	5	15	30	50
Active university–industry partnership agreements	200	600	1,200	2,000
Industry-funded collaborative research projects	100	400	900	1,500
Value of industry-funded research (~~₦~~ Billion/year)	~~₦~~10B	~~₦~~35B	~~₦~~80B	~~₦~~150B
Annual industrial internship placements for STEM students	25,000	80,000	180,000	300,000
STEM curricula reviewed with industry participation	15%	60%	90%	100%

Students completing entrepreneurship education annually	100,000	400,000	800,000	1.2 million
Academic staff trained in innovation and entrepreneurship	2,000	8,000	18,000	30,000
Innovation competitions conducted annually	10	30	50	75
Research prototypes developed annually	150	600	1,200	2,000
Patents filed annually by HEIs	80	250	600	1,200
Patents granted annually	25	120	300	700
Technologies licensed to industry annually	15	80	200	500
Commercialized research outputs annually	20	100	300	700
Annual commercialization revenue (₦ Billion)	₦2B	₦10B	₦30B	₦75B
University spin-off companies created annually	30	120	300	600
STEM startups incubated annually	150	600	1,500	3,000
Startup survival rate after three years	30%	45%	60%	75%
Seed grants awarded to innovators annually	200	800	2,000	4,000
Venture capital/private investment mobilized (₦ Billion/year)	₦5B	₦30B	₦75B	₦150B
Innovation Challenge Grants awarded annually	100	400	1,000	2,000
Graduate self-employment/entrepreneurship rate	8%	15%	25%	40%
STEM graduate employment within 12 months	45%	60%	75%	90%
Women participating in innovation programmes	30%	40%	45%	50%
Youth-led startups supported	300	1,000	2,500	5,000
Regional innovation centres established	6	12	18	24
International university-industry research partnerships	40	120	250	500
International technology commercialization agreements	10	40	100	200
Annual National Innovation Expo participation	500 exhibitors	1,000	2,000	3,500
Annual private-sector investment in university innovation (₦ Billion)	₦15B	₦40B	₦90B	₦180B
Institutions publishing annual innovation performance reports	10%	50%	80%	100%
HEIs with functioning Industry Advisory Boards	25%	70%	95%	100%

Timeline

The implementation of the **Innovation, Entrepreneurship and Industry Linkages** component will follow a **three-phase approach over a ten-year period (2026–2035)** as in Table 5.23. The phased implementation allows for systematic policy development, institutional capacity building, infrastructure expansion, ecosystem strengthening, and sustainable commercialization of research outputs. The timeline aligns with the overall Nigeria STEM

Transformation Strategy and provides sufficient flexibility for periodic review, learning, and scaling of successful interventions.

Table 5.23: Consolidated 10-Year Implementation Schedule

Major Activity	2026–2028	2029–2032	2033–2035
Policy and governance reforms	●	●	
Curriculum reform	●	●	
Innovation centres and hubs	●	●	●
Technology Transfer Offices	●	●	●
Intellectual property systems	●	●	●
University–industry partnerships	●	●	●
Research commercialization		●	●
Startup incubation and acceleration	●	●	●
Innovation financing	●	●	●
Technology parks		●	●
International partnerships		●	●
Venture capital mobilization		●	●
Monitoring and evaluation	●	●	●
Sustainability and global competitiveness			●

Expected Outcomes

Expected Outputs (End of Phase I)

1. National policy framework approved.
2. Innovation centres established in at least 40% of HEIs.
3. Technology Transfer Offices operational in major universities.
4. Entrepreneurship integrated into STEM curricula.
5. National innovation funding mechanism established.

Expected Outputs (End of Phase II)

1. Functional innovation ecosystem in most HEIs.
2. Significant increase in patents, startups, and commercialized technologies.
3. Strong university-industry partnerships nationwide.
4. Increased private-sector investment in research and innovation.
5. National network of innovation hubs and technology parks established.

Expected Outputs (End of Phase III)

1. Innovation and entrepreneurship fully institutionalized across Nigerian higher education.
2. Nigeria recognized as a regional leader in university-led innovation and technology commercialization.
3. Strong global research and industrial partnerships.
4. Sustainable financing for innovation and entrepreneurship.
5. Increased contribution of higher education innovation to national economic growth and industrial development.

5.5 Doctoral and Postdoctoral Expansion

Introduction

The **Doctoral and Postdoctoral Expansion** component of Nigeria's STEM Transformation Strategy for Higher Education is designed to strengthen the nation's research and innovation ecosystem by significantly increasing the number, quality, diversity, and global competitiveness of doctoral (PhD) and postdoctoral researchers in Science, Technology, Engineering, and Mathematics (STEM). Advanced research training is the foundation of knowledge creation, technological innovation, industrial competitiveness, and evidence-based policymaking. Countries that have successfully transitioned to knowledge-driven economies have consistently invested in expanding doctoral education, research excellence, international collaboration, and structured postdoctoral career pathways.[90]

Nigeria possesses one of Africa's largest higher education systems and a growing youthful population, yet the country continues to face shortages of highly skilled researchers, inadequate doctoral funding, limited postdoctoral opportunities, ageing academic staff, and significant brain drain. Many universities struggle with low doctoral completion rates, insufficient research infrastructure, inadequate supervision capacity, weak international research collaboration, and limited industry engagement. Postdoctoral research positions remain scarce, reducing opportunities for early-career researchers to transition into independent investigators and innovation leaders. These challenges constrain Nigeria's ability to generate cutting-edge scientific discoveries, develop indigenous technologies, commercialize research outputs, and compete in the global knowledge economy.[91] Expanding doctoral and postdoctoral education is therefore essential for building a sustainable pipeline of researchers capable of addressing Nigeria's national development priorities.

This strategy seeks to produce a new generation of globally competitive researchers equipped with interdisciplinary skills, entrepreneurial capabilities, digital competencies, and strong industry engagement. Modern doctoral education increasingly emphasizes the "knowledge triangle" the integration of education, research, and innovation through partnerships between universities, industry, government, and international institutions to ensure that research addresses societal and economic needs.[92] This pillar further aims to establish structured national doctoral scholarship programmes, competitive postdoctoral fellowships, joint, double and dual-degree doctoral programmes, international mobility schemes, industrial PhDs, interdisciplinary research schools, and centres of doctoral excellence. It also prioritizes strengthening research supervision, improving graduate employability, promoting gender equity and regional inclusion, attracting Nigerian researchers in the diaspora, and creating clear academic career pathways that retain top talent within the country's higher education and research institutions. These interventions will help reverse brain drain while positioning Nigeria as a regional hub for advanced STEM research and innovation. Ultimately, investing

[90] OECD. (2025). Education at a Glance 2025; UNESCO. (2022). Knowledge-driven Actions: Transforming Higher Education for Global Sustainability.
[91] T. E. Joshua & O. Adeyinka (2026), Reforming Higher Education for Graduate Employability in Nigeria: Policy Direction for Industrial–Institutional Collaboration. American Journal of STEM Education: Issues and Perspectives, 22, 11-30. DOI: https://doi.org/10.32674/hrmf4b38.
[92] I. Etomaru & D. T. Ofoyuru (2025), Doctoral education and the knowledge triangle: dynamics of linkage to other sectors in doctoral programs in Uganda. Studies in Graduate and Postdoctoral Education, 17 (3): 265–280.

in doctoral and postdoctoral expansion will accelerate the development of a knowledge-based economy capable of driving industrialization, technological advancement, sustainable development, and long-term national competitiveness in line with the Federal Government's education, science, technology, and innovation priorities as well as the Sustainable Development Goals (SDGs).

Vision

'To build a globally competitive Nigerian STEM ecosystem driven by high-quality doctoral education, world-class research infrastructure, innovation commercialization, and sustainable postdoctoral talent development".

Mission

To strengthen Nigeria's research and innovation ecosystem by expanding access to high-quality doctoral and postdoctoral training, enhancing research excellence, fostering international and industry partnerships, promoting inclusiveness, and developing the next generation of STEM leaders capable of solving national and global challenges.

Strategic Goals

The strategic goals (Table 5.24) of the **Doctoral and Postdoctoral Expansion** component are designed to build a robust and sustainable pipeline of highly skilled STEM researchers who will drive scientific discovery, technological innovation, industrial competitiveness, and socio-economic development in Nigeria. The goals align with Nigeria's aspirations to transition to a knowledge-based economy by strengthening doctoral education, expanding postdoctoral opportunities, improving research quality, fostering international collaboration, enhancing industry engagement, and promoting inclusiveness. Together, these goals seek to position Nigerian higher education institutions as globally competitive centres for advanced research and innovation while addressing national development priorities.

Table 5.24: The strategic goals of the Doctoral and Postdoctoral Expansion

Strategic Goal	Desired Outcomes
1. Expand access to high-quality doctoral education in STEM disciplines.	Increased enrolment and graduation of doctoral students across universities, polytechnics (where applicable), and colleges of education offering postgraduate programmes. Improved regional and gender balance in doctoral admissions. Greater participation of underrepresented groups in advanced STEM research.
2. Establish a national postdoctoral research and fellowship system.	Creation of structured postdoctoral fellowships in priority STEM fields. Increased number of early-career researchers transitioning to independent research careers. Enhanced research leadership and academic succession planning.
3. Improve the quality and international competitiveness of doctoral and postdoctoral training.	Adoption of internationally benchmarked doctoral curricula and supervision standards. Higher doctoral completion rates and reduced time-to-degree. Increased international accreditation and recognition of Nigerian doctoral programmes.
4. Strengthen research supervision, mentorship, and academic career development.	Improved supervisor capacity through certification and continuous professional development. Structured mentorship programmes for doctoral candidates and postdoctoral fellows. Stronger research ethics, leadership, and professional skills among researchers.

5. Increase funding and scholarships for doctoral and postdoctoral researchers.	Expanded government, industry, and donor-funded scholarships and fellowships. Reduced financial barriers to advanced STEM education. Increased participation of economically disadvantaged students.
6. Promote interdisciplinary, industry-linked, and challenge-driven research.	Growth in industry-sponsored doctoral research and Industrial PhD programmes. Increased collaborative research addressing national priorities such as health, agriculture, energy, AI, climate resilience, manufacturing, and water security. Higher commercialization of research outputs.
7. Strengthen international collaboration and researcher mobility.	Increased joint doctoral programmes, cotutelle arrangements, and dual-degree programmes. Expanded international exchange opportunities for doctoral students and postdoctoral fellows. Increased global research collaborations and co-authored publications.
8. Attract, retain, and engage Nigerian STEM talent.	Reduced brain drain through competitive research opportunities and career pathways. Increased participation of Nigerian diaspora researchers in supervision, teaching, and collaborative research. Improved retention of outstanding doctoral graduates and postdoctoral researchers within Nigerian institutions.
9. Enhance research productivity, innovation, and commercialization.	Increased publications in high-impact journals. Growth in patents, prototypes, technology transfer, and spin-off companies. Stronger contribution of universities to Nigeria's innovation ecosystem and industrial development.
10. Promote equity, diversity, and inclusion in advanced STEM research training.	Increased participation of women, persons with disabilities, and underserved regions in doctoral and postdoctoral programmes. Reduced regional disparities in research capacity. More inclusive and equitable access to research funding and opportunities.
11. Strengthen governance, quality assurance, and monitoring of doctoral and postdoctoral programmes.	National quality standards for doctoral and postdoctoral education implemented. Comprehensive monitoring and evaluation system for research training programmes. Evidence-based planning and continuous improvement across institutions.
12. Align doctoral and postdoctoral expansion with national development priorities.	Research outputs directly supporting national priorities including food security, renewable energy, digital transformation, biotechnology, advanced manufacturing, public health, environmental sustainability, and the blue economy. Increased contribution of STEM research to economic diversification and sustainable development.

Strategic Activities

The activities and programmes under the **Doctoral and Postdoctoral Expansion** component are designed to operationalize the strategic goals by expanding access to advanced STEM research training, improving research quality, strengthening supervision and mentorship, increasing funding opportunities, and enhancing collaboration between academia, industry, government, and international partners. The programmes focus on building a sustainable pipeline of highly skilled researchers capable of driving innovation, commercialization, and national development. Each activity is accompanied by measurable Key Performance Indicators (KPIs) (Table 5.25) to facilitate effective monitoring, evaluation, and evidence-based decision-making throughout implementation.

Table 5.25: Activities, Programmes and KPIs for Doctoral and Postdoctoral Expansion

Strategic Activity	Programme(s)	Key Performance Indicators (KPIs)
1. Expand national doctoral scholarships in priority STEM disciplines	National STEM Doctoral Scholarship Programme Presidential STEM Scholarship Scheme• Women in STEM PhD Scholarship Initiative	Number of doctoral scholarships awarded annually. Percentage increase in STEM PhD enrolment Female participation rate. Regional distribution of beneficiaries
2. Establish a National Postdoctoral Fellowship Programme	National STEM Postdoctoral Fellowship Scheme Early Career Research Fellowship Programme	Number of postdoctoral fellowships awarded. Percentage of fellows retained in Nigerian institutions Number of independent research projects initiated
3. Strengthen doctoral supervision and mentorship	National Supervisor Certification Programme. Doctoral Mentorship Network. Research Leadership Academy	Number of certified supervisors Supervisor-to-student ratio. Student satisfaction with supervision Doctoral completion rate
4. Modernize doctoral curricula and research training	Graduate Research School Initiative. Research Methods and Digital Skills Programme. Responsible Research and Ethics Training	Number of institutions adopting revised curricula. Percentage of doctoral students completing research skills training. Research integrity compliance rate
5. Promote interdisciplinary and challenge-driven research	Grand Challenge Doctoral Research Programme. Interdisciplinary Research Clusters. National Research Challenge Grants	Number of interdisciplinary projects funded. Number of cross-faculty collaborations. Research outputs addressing national priorities
6. Expand industrial doctoral programmes	Industrial PhD Programme Industry-Based Doctoral Internships. Industry Co-supervision Scheme	Number of Industrial PhD candidates. Number of industry partners engaged. Graduate employment rate in industry
7. Increase international collaboration and researcher mobility	Joint PhD Programme. Cotutelle Doctoral Scheme. International Visiting Scholar Programme	Number of joint degrees established. Number of international exchange participants. Number of international co-authored publications
8. Improve research infrastructure for doctoral and postdoctoral training	Shared Research Facilities Programme. Graduate Laboratory Upgrade Initiative. Digital Research Infrastructure Programme	Number of laboratories upgraded Utilization rate of research facilities. Student access to advanced research equipment
9. Support research publication and commercialization	Publication Support Fund. Patent Support Programme. Innovation and Commercialization Accelerator	Number of peer-reviewed publications. Number of patents filed. Number of technologies commercialized Number of start-ups/spin-offs created
10. Promote inclusion, gender equity and regional participation	Women in Research Initiative. Underrepresented region STEM Research Support Programme. Inclusive Research Fellowship Scheme	Female doctoral enrolment (%) Number of fellows from underserved regions. Number of institutions implementing inclusive policies
11. Attract and engage Nigerian STEM diaspora	Diaspora Visiting Professor Programme. Diaspora Research Collaboration Grants, Global Nigerian Research Network	Number of diaspora researchers participating. Number of joint research projects. Number of co-supervised doctoral candidates
12. Strengthen research funding mechanisms	National Competitive Doctoral Research Grant. University Research Endowment Programme Public–Private Research Partnership Fund	Total research funding mobilized. Number of grants awarded. Percentage of externally funded doctoral projects
13. Enhance researcher career development	Research Leadership Development Programme. Academic Career Readiness Programme. Entrepreneurship for Researchers Initiative	Percentage of graduates employed within one year. Number of researchers completing leadership training. Number of researcher-led start-ups

14. Establish national quality assurance systems	National Doctoral Quality Framework Doctoral Programme Accreditation Scheme. Research Performance Assessment System	Number of accredited doctoral programmes. Average doctoral completion time. Programme quality assessment scores
15. Develop a national doctoral and postdoctoral data management system	National Graduate Research Information System (NGRIS) Doctoral and Postdoctoral Tracking Portal	Percentage of institutions connected to the platform. Availability of real-time doctoral data. Annual graduate tracer reports published

Responsibilities

Implementation of the **Doctoral and Postdoctoral Expansion** component requires coordinated action across the federal, state, institutional, industry, and international levels. Clearly defining responsibilities at each implementation level ensures accountability, minimizes duplication, and promotes effective collaboration among stakeholders. The matrix in Table 5.26 identifies the implementation level, responsible institutions, and expected deliverables for each strategic activity.

Table 5.26: Responsibility Matrix for the Doctoral and Postdoctoral Expansion Component

Strategic Activity/Programme	Implementation Level	Lead Responsibility	Supporting Institutions
Develop national policy and regulatory framework for doctoral and postdoctoral expansion	National	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education
Establish National STEM Doctoral Scholarship Programme	National	Tertiary Education Trust Fund	Federal Ministry of Education, National Universities Commission, Development Partners
Establish National Postdoctoral Fellowship Programme	National	Tertiary Education Trust Fund	Universities, Research Institutes, Development Partners
Expand doctoral admissions in priority STEM fields	Institutional	Universities	National Universities Commission, TETFund
Modernize doctoral curricula and programme structure	National/Institutional	National Universities Commission	Universities, Professional Bodies, Industry
Strengthen doctoral supervision and mentorship	Institutional	Universities	National Universities Commission, International Partners
Establish Graduate Research Schools	Institutional	Universities	TETFund, National Universities Commission
Upgrade research infrastructure and laboratories	National/Institutional	Tertiary Education Trust Fund	Federal Ministry of Education, Universities, State Governments
Establish interdisciplinary doctoral research centres	Institutional	Universities	Research Institutes, Industry
Implement Industrial PhD Programme	National/Industry	Federal Ministry of Innovation, Science and Technology	Industry, Universities

Promote university-industry collaboration	National/Industry	Federal Ministry of Innovation, Science and Technology	Industry Associations, Universities
Support publication, patents and commercialization	Institutional/National	Tertiary Education Trust Fund	Universities, Technology Transfer Offices, Industry
Develop international doctoral partnerships	International/National	Federal Ministry of Education	Ministry of Foreign Affairs, Universities, International Universities
Implement researcher mobility programmes	International	Federal Ministry of Education	International Partners, Development Agencies
Establish Diaspora Research Engagement Programme	International/National	Nigerians in Diaspora Commission	Universities, Ministry of Foreign Affairs
Promote gender equity and regional inclusion	National/State/Institutional	Federal Ministry of Education	State Ministries of Education, Universities, Ministry of Women Affairs
Strengthen research ethics and integrity	National/Institutional	National Universities Commission	Universities, Professional Bodies
Develop National Doctoral Information Management System	National	National Universities Commission	TETFund, Universities
Monitor and evaluate programme implementation	National	Federal Ministry of Education	National Universities Commission, National Bureau of Statistics, Universities
Mobilize sustainable funding	National	Federal Ministry of Education	Ministry of Finance, TETFund, Development Partners, Industry

Key Performance Indicators

The Key Performance Indicators (KPIs) for the **Doctoral and Postdoctoral Expansion** component provide measurable benchmarks for assessing progress towards strengthening Nigeria's advanced STEM research capacity (Table 5.27). The indicators align with the strategic goals of expanding doctoral enrolment, improving research quality, increasing postdoctoral opportunities, promoting innovation, enhancing international competitiveness, and strengthening university-industry collaboration. Baseline values should be established through a national assessment coordinated by the Federal Ministry of Education, National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, and Tertiary Education Trust Fund during the first year of implementation.

Table 5.27: Key Performance Indicators

KPI	Baseline (2026)	Short-Term (2028)	Medium-Term (2031)	Long-Term (2035)
Annual STEM doctoral enrolment	National baseline established	25% increase	75% increase	150% increase
Annual STEM doctoral graduates	Baseline established	20% increase	60% increase	120% increase
Doctoral completion rate	Baseline established	70%	80%	≥90%
Average doctoral completion time	Baseline established	Reduced by 10%	Reduced by 20%	Reduced by 30%
Number of national doctoral scholarships awarded annually	Existing scholarships	2,500	5,000	8,000
Number of postdoctoral fellowships awarded annually	<100	500	1,500	3,000
Universities with structured postdoctoral programmes	Limited	30 institutions	60 institutions	All eligible public universities and selected private universities
Certified doctoral supervisors	Baseline established	2,000	5,000	8,000
Supervisor-to-doctoral student ratio	Baseline established	1:8	1:6	1:5
Universities with Graduate Research Schools	Baseline established	40%	70%	100%
Industry-sponsored doctoral research projects	Limited	200	600	1,200
Number of Industrial PhD candidates	Minimal	500	2,000	5,000
Joint doctoral degree programmes	Baseline established	30	80	150
International mobility participation (doctoral/postdoctoral)	Baseline established	500 researchers	2,000 researchers	5,000 researchers
High-impact peer-reviewed STEM publications from doctoral/postdoctoral research	Baseline established	30% increase	80% increase	200% increase
Citation impact of doctoral research	Baseline established	20% increase	60% increase	150% increase
Patents arising from doctoral/postdoctoral research	Baseline established	100 patents/year	300 patents/year	700 patents/year
Research commercialization projects	Baseline established	50	150	400
Start-ups/spin-offs established by doctoral graduates	Baseline established	50	150	300
Female participation in doctoral STEM programmes	Approximately 30%*	35%	40%	≥45%
Participation from underserved regions	Baseline established	20% increase	50% increase	100% increase
Nigerian diaspora researchers engaged annually	Limited	150	500	1,000
External research funding secured for doctoral/postdoctoral research	Baseline established	30% increase	75% increase	150% increase
Graduate employment within one year	Baseline established	75%	85%	≥95%

Universities connected to the National Doctoral Information Management System	0	50%	80%	100%
Annual monitoring and evaluation reports published	Limited	Annual reports produced	Annual reports with performance dashboards	Fully integrated national monitoring system

Timeline

Table 5.28: Implementation Timeline (2026–2035)

Strategic Activity	2026–2027 (Foundation Phase)	2028–2030 (Scale-up Phase)	2031–2033 (Expansion Phase)	2034–2035 (Consolidation Phase)
Develop National Doctoral and Postdoctoral Policy Framework	●			
Establish National STEM Doctoral Scholarship Programme	●	●	●	●
Launch National Postdoctoral Fellowship Programme	●	●	●	●
Review and modernize doctoral curricula	●	●		
Establish Graduate Research Schools	●	●	●	
Upgrade research laboratories and digital research infrastructure	●	●	●	●
National Supervisor Certification Programme	●	●	●	●
Research mentorship and leadership programmes	●	●	●	●
Expand doctoral enrolment in priority STEM disciplines	●	●	●	●
Implement Industrial PhD Programme	●	●	●	●
Strengthen university–industry partnerships	●	●	●	●
Establish interdisciplinary research centres		●	●	●
Develop joint PhD and cotutelle programmes	●	●	●	●

International researcher mobility programmes	●	●	●	●
Diaspora STEM Engagement Programme	●	●	●	●
Research publication and commercialization support	●	●	●	●
National Doctoral Information Management System	●	●	●	●
Gender equity and regional inclusion initiatives	●	●	●	●
Monitoring, evaluation and annual performance reviews	●	●	●	●

Expected Outcomes

Table 5.29: Expected outcomes for each phase of implementation

Implementation Phase	Expected Outcomes
Phase I: Foundation (2026–2027)	National policy and regulatory framework established. National doctoral scholarship and postdoctoral fellowship programmes launched. Graduate Research Schools established in priority institutions. Supervisor certification and mentorship systems operational. National Doctoral Information Management System developed.
Phase II: Scale-up (2028–2030)	Increased doctoral enrolment and graduation. Expanded research infrastructure and digital laboratories. Operational Industrial PhD programmes. Stronger university–industry partnerships. Increased international collaboration and researcher mobility.
Phase III: Expansion (2031–2033)	Significant increase in research publications, patents and commercialization. Expanded interdisciplinary research centres. Greater participation of women and underserved regions. Increased external research funding and global partnerships.
Phase IV: Consolidation (2034–2035)	Nigeria recognized as a regional leader in doctoral and postdoctoral STEM education. Sustainable funding and governance systems institutionalized. Globally competitive doctoral programmes across higher education institutions. Strong contribution of research and innovation to national economic transformation.

5.6 Strengthening Linkages with Local Economy and Regions

Introduction

Nigeria possesses significant regional diversity in natural resources, industrial clusters, agricultural production systems, mineral deposits, renewable energy potential, cultural industries, and emerging digital economies. However, many higher education institutions remain weakly connected to these regional economic strengths, resulting in limited commercialization of research outputs, low technology adoption by local industries, graduate unemployment, and insufficient contributions of universities to regional productivity. Building stronger partnerships between higher education institutions and regional stakeholders, including state governments, local industries, SMEs, agricultural enterprises, technology hubs, chambers of commerce, development agencies, and civil society organizations will enable

STEM education and research to address local development priorities while supporting national economic transformation.[93]

Within Nigeria's STEM Transformation Strategy for Higher Education, the **Strengthening Linkages with Local Economy and Regions** component seeks to establish place-based innovation ecosystems that align institutional research, education, and innovation activities with regional development priorities. The strategy promotes collaborative research, regional innovation hubs, technology transfer, entrepreneurship support, workforce development, community-based innovation, and the co-creation of solutions for agriculture, manufacturing, healthcare, energy, environmental sustainability, digital transformation, and other strategic sectors. By leveraging local comparative advantages, higher education institutions can become anchors of regional competitiveness and inclusive economic development while fostering resilient innovation ecosystems across Nigeria's six geopolitical zones.

Vison

To create an integrated national ecosystem where every higher education institution serves as a catalyst for regional economic transformation through innovation, industry collaboration, technology commercialization, and community engagement.

Mission

To align STEM education, research, and innovation with the comparative advantages and development priorities of Nigeria's states and regions by promoting university–industry–government collaboration, supporting local enterprise development, strengthening regional innovation ecosystems, and enhancing the socioeconomic impact of higher education**.**

Strategic goals

Strengthening linkages between higher education institutions (HEIs), local economies, industries, and regional stakeholders is essential for ensuring that STEM education and research contribute directly to Nigeria's socioeconomic transformation. The following strategic goals are designed to position universities, polytechnics, and colleges of education as catalysts for regional innovation, industrial competitiveness, entrepreneurship, workforce development, and sustainable development in alignment with the **National Development Plan (2021–2025)**, the **National Science, Technology and Innovation Policy (2022)**, and global best practices promoted by UNESCO, the World Bank, and the OECD.

Table 5.30: Strategic Goals and Desired Outcomes for Strengthening Linkages with Local Economy and Regions

Strategic Goal	Description	Desired Outcomes
1. Align STEM Education and Research with Regional Economic Priorities	Ensure that curricula, research programmes, and innovation activities address the comparative advantages and development needs of each geopolitical zone and state, including agriculture, manufacturing, renewable energy, ICT,	STEM programmes aligned with regional priorities. Increased relevance of graduate skills. Improved productivity and competitiveness of local industries.

[93] World Bank (2025). Digital Skills, Innovation, and Economic Transformation: Opportunities and Challenges for Sub-Saharan Africa.

	mining, health, blue economy, and the creative industries.	Greater regional economic diversification.
2. Strengthen University–Industry–Government Collaboration	Build long-term partnerships among HEIs, industries, government agencies, chambers of commerce, SMEs, development partners, and civil society to promote collaborative research, innovation, policy development, and workforce development.	Increased collaborative research projects. Stronger industry participation in curriculum design. Higher levels of technology transfer and commercialization. Sustainable regional innovation ecosystems.
3. Promote Regional Innovation and Technology Transfer Ecosystems	Establish regional innovation hubs, technology transfer offices, incubators, science parks, makerspaces, and innovation clusters that accelerate commercialization of research outputs and indigenous technologies.	More patents, licenses, and spin-off companies. Increased startup creation and survival rates. Enhanced commercialization of research. Growth of regional innovation ecosystems.
4. Enhance Graduate Employability and Workforce Development	Strengthen work-integrated learning through internships, apprenticeships, industrial attachments, professional certification, and employer engagement to produce industry-ready STEM graduates.	Higher graduate employment rates.. increased employer satisfaction. Expanded internship opportunities. Reduced skills mismatch between graduates and industry needs.
5. Support Entrepreneurship and Local Enterprise Development	Foster entrepreneurial education and provide technical support, mentoring, business incubation, seed funding, and innovation financing for students, researchers, and community entrepreneurs.	Increased STEM startups and SMEs. Higher business survival rates. More innovation-driven enterprises. Job creation and local wealth generation.
6. Strengthen Community Engagement and Social Innovation	Encourage HEIs to co-create practical solutions with communities through participatory research, extension services, citizen science, and social innovation programmes that address local challenges.	Increased community-based innovation projects. Improved livelihoods. Greater adoption of evidence-based local solutions. Stronger public trust in higher education institutions.
7. Develop Regional Research and Innovation Networks	Promote collaboration among universities, polytechnics, colleges of education, research institutes, state governments, and industries within and across regions to maximize resources and expertise.	Functional regional research consortia. Shared research infrastructure. Increased interdisciplinary research. Improved research quality and impact.
8. Strengthen Regional Skills Intelligence and Labour Market Information Systems	Establish mechanisms for continuous labour market analysis to inform curriculum review, workforce planning, and investment decisions in STEM education.	Data-driven curriculum development. Improved workforce planning. Better alignment between education and labour market needs. Higher graduate employability.
9. Mobilize Regional Investment and Sustainable Financing	Attract investment from state governments, industries, development finance institutions, philanthropic organizations, and the private sector to support STEM innovation and regional development initiatives.	Increased public-private investment. Sustainable funding for innovation. Expanded regional development projects. Greater financial resilience of innovation ecosystems.
10. Promote Inclusive Regional Development and Balanced Growth	Ensure equitable participation of underserved regions, women, youth, persons with disabilities, and marginalized communities in STEM education, innovation, and entrepreneurship programmes.	Reduced regional disparities. Increased participation of women and youth. More inclusive innovation ecosystems. Balanced national socioeconomic development.

Strategic Activities

Achieving stronger linkages between higher education institutions (HEIs) and local economies requires coordinated programmes that integrate teaching, research, innovation, entrepreneurship, workforce development, and community engagement. The activities outlined below are designed to transform universities, polytechnics, and colleges of education into regional innovation anchors that support state and national development priorities. These programmes align with Nigeria's **National Development Plan (2021–2025)**, the **National Science, Technology and Innovation (STI) Policy (2022)**, and international good practices promoted by UNESCO, the OECD, and the World Bank.

Table 5.31: Strategic activities and programmes to strengthen linkages with local economy and regions

Strategic Goal	Activity	Programme	Key Performance Indicators (KPIs)
1. Align STEM Education and Research with Regional Economic Priorities	Conduct regional STEM needs assessments and institutional mapping, Conduct periodic regional labour market needs	Regional STEM Needs Assessment Programme. Regional STEM labour market Assessment	Number of regional skills assessments completed Percentage of STEM programmes aligned with regional priorities Number of curricula revised using labour market data
	Develop state and regional STEM development roadmaps	Regional STEM Development Planning Initiative	Number of state STEM roadmaps developed Number of stakeholder consultations conducted Percentage of institutions implementing regional priorities
2. Strengthen University–Industry–Government Collaboration	Establish University–Industry Liaison Offices	University-Industry Partnership Programme	Number of liaison offices established. Number of industry partnerships signed. Annual value of collaborative projects
	Create Regional Industry Advisory Boards	Industry Advisory Council Initiative	Number of advisory boards established. Frequency of meetings held. Number of recommendations implemented
	Organize annual regional innovation forums	Regional STEM Innovation Forum	Number of forums organized annually. Number of participating organizations. Number of partnership agreements signed
3. Promote Regional Innovation and Technology Transfer	Establish Technology Transfer Offices (TTOs)	Regional Technology Transfer Programme	Number of TTOs operational. Number of technologies disclosed Number of licensing agreements executed
	Develop innovation hubs, makerspaces, and science parks	Regional STEM Innovation Hub Programme	Number of innovation hubs established. Number of startups incubated. Startup survival rate after three years

	Support commercialization of research	Regional Research Commercialization Fund	Number of prototypes developed• Number of products commercialized Revenue generated from commercialization
4. Enhance Graduate Employability and Workforce Development	Expand internships and industrial attachments	National STEM Internship Programme	Percentage of STEM students completing internships. Number of industry placements annually. Employer satisfaction rate
	Introduce apprenticeships and cooperative education schemes	Regional STEM Apprenticeship Initiative	Number of apprentices trained. Graduate employment rate within 12 months. Number of participating employers
	Develop professional certification pathways	Industry Certification Programme	Number of students obtaining certifications Number of certification partnerships established
5. Support Entrepreneurship and Local Enterprise Development	Strengthen entrepreneurship centres forcused on regional economies	Campus Entrepreneurship Development Programme	Number of entrepreneurship centres strengthened. Number of students trained annually
	Provide startup incubation and mentoring for solutions addressing regional challenegs	STEM Startup Accelerator Programme	Number of startups incubated. Startup survival rate. Amount of investment mobilized
	Establish innovation seed funding	Regional Innovation Seed Fund	Value of grants awarded Number of businesses funded• Number of jobs created
6. Strengthen Community Engagement and Social Innovation	Promote community-based participatory research	Community Innovation Partnership Programme	Number of community projects implemented• Number of beneficiaries reached Community satisfaction index
	Expand STEM outreach and extension services	University Extension Services Initiative	Number of outreach programmes conducted Number of communities served• Adoption rate of technologies
7. Develop Regional Research and Innovation Networks	Establish regional research consortia	Regional Research Collaboration Network	Number of research networks formed. Number of joint publications. Number of collaborative grants secured
	Promote shared research infrastructure	Shared Research Infrastructure Programme	Number of institutions sharing facilities. Equipment utilization rate. Reduction in duplication of infrastructure
8. Strengthen Regional Skills Intelligence Systems	Develop labour market information systems	Regional STEM Skills Observatory	National labour market database established. Annual skills reports published. Number of institutions using labour market intelligence
	Conduct annual employer surveys	Employer Engagement Survey Programme	Employer response rate Graduate skills satisfaction index. Number of curriculum improvements informed by surveys

9. Mobilize Regional Investment and Sustainable Financing	Establish regional innovation investment platforms	Regional Innovation Investment Programme	Value of investment mobilized. Number of investors participating. Number of funded innovation projects
	Develop Public–Private Partnership (PPP) frameworks	STEM Partnership Financing Initiative	Number of PPP agreements signed• Private sector contribution to STEM funding Number of joint investment projects
10. Promote Inclusive Regional Development	Expand participation of women, youth, and underserved communities	Inclusive STEM Regional Development Programme	Female participation rate in STEM programmes. Number of underserved communities reached. Number of beneficiaries from targeted groups
	Support innovation for local community challenges	Regional Grand Challenges Programme	Number of challenge grants awarded. Number of locally developed solutions adopted. Socioeconomic impact assessment completed

Responsibilities

The successful implementation of the **Strengthening Linkages with Local Economy and Regions** component requires clearly defined institutional roles and coordinated action across national, state, and institutional levels. Given the multi-sectoral nature of regional innovation and economic development, effective collaboration among government ministries, regulatory agencies, higher education institutions, industry, development partners, and local communities is essential to ensure that STEM education, research, and innovation respond to regional development priorities and contribute to sustainable economic growth. The responsibility matrix presented in Table 5.32 establishes a governance framework that assigns leadership and supporting roles for each strategic activity while promoting accountability, coordination, and efficient resource utilization. It also clarifies implementation responsibilities at the **national**, **state**, and **institutional** levels, ensuring alignment with Nigeria's **National Development Plan (2021–2025)**, the **National Science, Technology and Innovation Policy (2022)**, and international best practices for university–industry–government collaboration. By adopting this structured implementation approach, higher education institutions can serve as catalysts for regional innovation, technology commercialization, workforce development, entrepreneurship, and inclusive socioeconomic transformation.

Table 5.32: Responsibility Matrix for Strengthening Linkages with Local Economy and Regions

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level
Develop a national framework for strengthening higher education linkages with local economies and regional development	Federal Ministry of Education (FME); Federal Ministry of Innovation, Science and Technology (FMIST)	National Universities Commission (NUC); National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); TETFund	National

Conduct regional economic, labour market, and STEM skills assessments	FMIST; Federal Ministry of Labour and Employment	National Bureau of Statistics (NBS); NUC; NBTE; NCCE; State Ministries of Education; State Ministries of Science and Technology	National, State
Align STEM curricula and research priorities with regional economic needs	NUC; NBTE; NCCE	FME; FMIST; Professional Bodies; Industry Advisory Boards; HEIs	National, Institutional
Establish University–Industry Liaison Offices in all HEIs	Higher Education Institutions (Universities, Polytechnics, Colleges of Education)	NUC; NBTE; NCCE; TETFund; Industry Associations	Institutional
Create Regional Industry Advisory Councils	State Governments	Chambers of Commerce; Manufacturers Association of Nigeria (MAN); Nigeria Association of Small and Medium Enterprises (NASME); HEIs	State, Institutional
Establish Technology Transfer Offices (TTOs)	Higher Education Institutions	FMIST; NUC; TETFund; Nigerian Office for Technology Acquisition and Promotion (NOTAP)	Institutional
Develop Regional Innovation Hubs, Science Parks, and Makerspaces	FMIST; State Governments	TETFund; HEIs; Private Sector; Development Partners	National, State, Institutional
Promote collaborative university–industry research and innovation projects	Higher Education Institutions	TETFund; FMIST; Industry Partners; Research Institutes	Institutional
Expand internship, industrial attachment, and cooperative education programmes	Higher Education Institutions	Industrial Training Fund (ITF); Employers; Professional Bodies; NUC; NBTE; NCCE	Institutional
Implement STEM apprenticeship programmes	NBTE; Industrial Training Fund (ITF)	Polytechnics; Technical Colleges; Employers; State Governments	National, State, Institutional
Strengthen entrepreneurship education and startup incubation	Higher Education Institutions	TETFund; Bank of Industry (BOI); Small and Medium Enterprises Development Agency of Nigeria (SMEDAN); Private Investors	Institutional
Establish Regional Research and Innovation Consortia	FMIST	NUC; TETFund; Research Institutes; State Governments; HEIs	National, State, Institutional
Promote community-based research, extension services, and social innovation	Higher Education Institutions	Local Governments; Community-Based Organizations; NGOs; Traditional Institutions	Institutional, State
Develop a National STEM Skills Observatory and Labour Market Information System	FMIST	NBS; Federal Ministry of Labour and Employment; NUC; NBTE; NCCE	National
Organize annual Regional STEM Innovation and Investment Forums	State Governments	FMIST; FME; HEIs; Chambers of Commerce; Development Partners	State
Mobilize public-private partnerships (PPPs) and	FMIST; Federal Ministry of Finance	TETFund; Nigeria Sovereign Investment	National, State

regional investment for STEM innovation		Authority (NSIA); BOI; Development Finance Institutions; Private Sector	
Promote commercialization of research outputs and indigenous technologies	Higher Education Institutions	NOTAP; TETFund; FMIST; Patent Registry; Industry Partners	**Institutional**
Strengthen monitoring, evaluation, and impact assessment of university–regional partnerships	FME	FMIST; NUC; NBTE; NCCE; TETFund; State Governments; HEIs	**National, State, Institutional**
Establish regional centres for lifelong learning, reskilling, and workforce development	State Governments; Higher Education Institutions	National Board for Technical Education (NBTE); Industrial Training Fund (ITF); Employers; Development Partners	**State, Institutional**
Promote inclusive participation of women, youth, persons with disabilities, and underserved communities in regional STEM programmes	FME; Federal Ministry of Women Affairs	State Governments; NUC; NBTE; NCCE; HEIs; Civil Society Organizations; Development Partners	**National, State, Institutional**

Key Performance Indicators

The Key Performance Indicators (KPIs) presented in Table 5.33 track progress from the current baseline through short-, medium-, and long-term implementation horizons. They focus on institutional partnerships, research commercialization, graduate employability, entrepreneurship, regional innovation ecosystems, community engagement, and socioeconomic impact. These indicators align with Nigeria's **National Development Plan (2021–2025)**, the **National Science, Technology and Innovation Policy (2022)**, the **Sustainable Development Goals (SDGs)**, and international best practices promoted by UNESCO, OECD, and the World Bank.

Table 5.33: Key Performance Indicators for Strengthening Linkages with Local Economy and Regions

Key Performance Indicator	Baseline (2026)	Short-Term Target (2027–2029)	Medium-Term Target (2030–2032)	Long-Term Target (2033–2035)
HEIs with formal university–industry partnership frameworks	30%	60%	85%	100%
Active university–industry collaboration agreements	300	700	1,200	1,800
HEIs with functional University–Industry Liaison Offices	20%	50%	80%	100%
HEIs with operational Technology Transfer Offices (TTOs)	15%	40%	70%	100%
Regional Innovation Hubs/Science Parks established	10	20	30	37 (all states + FCT)
Regional Industry Advisory Councils established	6	18	30	37

Collaborative university–industry research projects completed annually	150	400	700	1,000
Research outputs commercialized	50	150	350	600
Patents licensed to industry	20	80	200	400
University spin-off/start-up companies created	80	250	600	1,200
External funding mobilized through university–industry partnerships	₦50 billion	₦150 billion	₦350 billion	₦700 billion
STEM students completing internships or industrial attachments	45%	70%	90%	100%
STEM graduates employed or self-employed within 12 months	55%	65%	75%	85%
Employers satisfied with graduate skills	50%	65%	80%	90%
Students trained in entrepreneurship annually	60,000	120,000	200,000	300,000
STEM startups incubated annually	200	500	1,000	2,000
Startup survival rate after three years	40%	55%	65%	75%
HEIs participating in regional research and innovation networks	30%	60%	85%	100%
Shared research infrastructure utilization rate	20%	45%	65%	85%
Community-based STEM innovation projects implemented annually	120	400	800	1,500
Communities benefiting from HEI extension and outreach programmes	500	1,500	3,000	5,000
Annual Regional STEM Innovation and Investment Forums held	6	18	30	37
States implementing regional STEM development plans	12	24	33	37 (including FCT)
Private-sector contribution to STEM innovation programmes	20%	30%	40%	50%
Female participation in regional STEM innovation programmes	32%	38%	45%	50%
Youth participation (18–35 years) in entrepreneurship and innovation programmes	45%	60%	75%	85%
Local SMEs adopting HEI-developed technologies	100	400	900	1,500
HEIs producing annual regional economic impact reports	10%	40%	70%	100%
Regional GDP contribution attributable to HEI innovation initiatives*	Baseline study to be conducted	+2%	+5%	+10%
Stakeholder satisfaction with HEI–regional partnerships	55%	70%	85%	95%

Timelines for Implementation

The implementation of the **Strengthening Linkages with Local Economy and Regions** component will be undertaken over a **10-year period (2026–2035)** using a phased approach to ensure sustainable institutional capacity, stakeholder engagement, and measurable impact. The timeline (Table 5.34) is divided into **three implementation phases**: **Foundation (Short Term)**, **Expansion (Medium Term)**, and **Consolidation (Long Term)**. This phased approach allows for progressive strengthening of university–industry partnerships, regional innovation ecosystems, technology commercialization, entrepreneurship, workforce development, and community engagement across Nigeria's higher education system.

Table 5.34: Implementation Timeline for Strengthening Linkages with Local Economy and Regions

Implementation Phase	Timeline	Major Activities
Phase I: Foundation and System Development	**2026–2028**	Develop national policy and implementation guidelines; establish governance structures; conduct regional needs assessments; align curricula with regional priorities; establish University–Industry Liaison Offices, Technology Transfer Offices, and Industry Advisory Councils; launch Regional STEM Skills Observatory; initiate innovation hubs and pilot university–industry partnerships.
Phase II: Expansion and Scaling	**2029–2032**	Scale collaborative research programmes, technology transfer, innovation hubs, science parks, entrepreneurship centres, startup incubation, apprenticeships, internships, community engagement initiatives, and regional research consortia; expand public-private partnerships and investment.
Phase III: Consolidation and Sustainability	**2033–2035**	Achieve nationwide institutional coverage; mature regional innovation ecosystems; strengthen commercialization of research; institutionalize university–industry collaboration; establish lifelong learning centres; enhance regional economic impact; conduct comprehensive programme evaluation and continuous improvement.

Expected Outcomes

The **Strengthening Linkages with Local Economy and Regions** component is expected to transform Nigeria's higher education institutions into key drivers of regional innovation, economic growth, and sustainable development. By strengthening partnerships among universities, polytechnics, colleges of education, industry, government, and local communities, STEM education and research will become more responsive to regional needs and national priorities. This will foster a culture of innovation, technology transfer, entrepreneurship, and community engagement that enhances the socioeconomic impact of higher education. Table 5.35 presents the expected outcomes in each phase of completion.

Table 5.35: Expected outcomes in Strengthening Linkages with Local Economy and Regions

Phase	Expected Outcomes
2026–2028 (Foundation)	National implementation framework established; institutional governance structures operational; regional economic priorities identified; initial university–industry partnerships and innovation support structures in place.
2029–2032 (Expansion)	Significant growth in collaborative research, technology commercialization, graduate employability, startup creation, regional innovation hubs, and private-sector investment in STEM.
2033–2035 (Consolidation)	Higher education institutions fully integrated into regional innovation ecosystems; sustainable university–industry partnerships; strong contribution of STEM to regional competitiveness, economic diversification, job creation, and inclusive development across all 36 states and the FCT.

CHAPTER SIX

STRENGTHENING OF STEM ENABLING FACTORS

6.1 Governance and Modernization of University Governance System

Introduction

Effective governance and institutional modernization are critical foundations for achieving a globally competitive, ICT-enabled STEM tertiary education system in Nigeria. According to the World Bank, governance systems determine the quality of leadership, accountability, resource management, policy implementation, innovation capacity, and institutional responsiveness to national development priorities.[94] Many Nigerian tertiary institutions continue to face governance challenges including excessive bureaucratic control, weak institutional autonomy, inadequate digital governance systems, political interference, poor accountability mechanisms, and limited strategic planning capacity. The UNESCO emphasizes that strengthening governance and modernizing university administration are essential for successful STEM transformation and sustainable higher education reform.[95]

The Governance and Modernization of University Governance System component of Nigeria's STEM Transformation Strategy seeks to establish a modern governance framework that enhances institutional effectiveness, strengthens leadership capacity, promotes transparency and accountability, digitizes university administration, and introduces performance-based planning and management systems. The strategy also emphasizes stronger collaboration among government agencies, governing councils, university management, academic staff, students, industry, and development partners to create responsive and resilient higher education institutions

This component further promotes the adoption of integrated digital governance platforms for academic administration, financial management, procurement, human resource management, quality assurance, research administration, and institutional performance monitoring. It supports the implementation of robust governance standards, risk management systems, internal quality assurance mechanisms, and data-driven decision-making processes aligned with international best practices. By strengthening governance structures and institutional leadership, Nigerian higher education will be better positioned to deliver quality STEM education, attract research funding, foster innovation ecosystems, and contribute more effectively to national industrialization and sustainable development.

Vision

“To position Nigerian universities as autonomous, digitally transformed, and performance-driven institutions that lead Africa in STEM education, research, and innovation.”.

[94] World Bank (2019). Improving Higher Education Governance in Africa. Washington, DC: World Bank Group.
[95] UNESCO (2021). Digital Transformation in Higher Education. Paris: United Nations Educational, Scientific and Cultural Organization.

Mission

"To modernize university governance through institutional autonomy, transparent leadership, digital transformation, evidence-based decision-making, performance management, stakeholder participation, and strengthened accountability mechanisms that enhance institutional effectiveness and support Nigeria's STEM transformation agenda."

Strategic Goals

The Governance and Modernization of University Governance System component aims to strengthen institutional leadership, improve accountability and transparency, modernize governance structures, and enhance the efficiency of university administration through digital transformation and performance-based management. The strategic goals presented in Table 6.1 focus on creating agile, autonomous, and well-governed universities capable of delivering high-quality STEM education, research, innovation, and community engagement while aligning with Nigeria's national development priorities and international best practices.

Table 6.1: Strategic goals and Desired Outcomes for Governance and Modernization of University Governance Systems

Strategic Goals	Desired Outcomes (Expected Results)
1. Strengthen Institutional Autonomy and Accountability	Universities operate with greater academic, administrative, and financial autonomy while maintaining strong accountability, transparency, and compliance with national regulations.
2. Modernize University Governance Structures	Governing Councils, Senate, management teams, and committees function effectively with clearly defined roles, improved governance practices, and timely decision-making processes.
3. Digitize University Governance and Administration	Integrated digital governance systems improve efficiency in academic administration, finance, procurement, human resources, student services, research management, and institutional reporting.
4. Strengthen Leadership Capacity and Succession Planning	University leaders possess modern leadership, strategic management, financial management, and change management competencies, supported by structured leadership development and succession plans.
5. Institutionalize Performance-Based Management Systems	Performance contracts, institutional scorecards, and key performance indicators guide university management, improve accountability, and enhance institutional performance.
6. Strengthen Quality Assurance and Regulatory Compliance	Robust internal quality assurance systems and regulatory compliance mechanisms improve academic standards, institutional effectiveness, accreditation outcomes, and continuous improvement.
7. Promote Data-Driven Decision-Making and Institutional Intelligence	Reliable institutional data, analytics, and management information systems support evidence-based planning, budgeting, policy formulation, and performance monitoring.
8. Improve Financial Governance and Resource Mobilization	Universities diversify revenue sources, strengthen financial controls, improve budget transparency, and ensure sustainable financing for STEM education and research.
9. Strengthen Risk Management, Internal Audit, and Corporate Governance	Comprehensive enterprise risk management, internal audit systems, and governance policies improve institutional resilience, integrity, and operational efficiency.
10. Enhance Stakeholder Participation and Shared Governance	Students, staff, alumni, industry, government agencies, communities, and development partners actively participate in institutional governance and strategic decision-making.

11. Promote Ethical Leadership, Transparency, and Integrity	Strong governance ethics, anti-corruption measures, conflict-of-interest policies, and transparent procurement systems increase public confidence in university administration.
12. Foster Internationalization and Global Governance Best Practices	Nigerian universities adopt internationally recognized governance standards, strengthen global partnerships, improve international rankings, and enhance institutional competitiveness.

Strategic Activities

Achieving modern, transparent, accountable, and digitally enabled university governance requires coordinated reforms across leadership, institutional systems, policies, digital infrastructure, financial management, and stakeholder engagement. The following strategic activities and programmes presented in Table 6.1 provide a practical implementation framework, while the Key Performance Indicators (KPIs) enable continuous monitoring of progress and institutional performance throughout the implementation period.

Table 6.2: Strategic Activities for Governance and Modernization of University Governance System

Strategic Activity	Programme(s)	Key Performance Indicators (KPIs)
1. Develop and implement a National University Governance Reform Framework	National Governance Reform Programme. University Governance Policy Review Initiative	National governance framework approved. Number of governance policies reviewed and updated. Percentage of universities adopting the framework
2. Strengthen Governing Councils and Senate effectiveness	University Governing Council Capacity Development Programme. Senate Governance Enhancement Initiative. Merit-based appointments of governing council members.	Number of council members trained Percentage of councils meeting governance standards. Frequency of governance performance evaluations; Governing councils to make strategic decisions based on institutional priorities
3. Introduce performance-based university management	Performance Contract Programme for Vice-Chancellors and Principal Officers. Institutional Performance Scorecard Initiative	Percentage of universities implementing performance contracts. Annual institutional performance scorecards published. Improvement in institutional performance ratings
4. Digitize university governance and administration	Smart University Digital Governance Programme Integrated, University Management Information System (UMIS) Deployment	Percentage of universities using integrated digital management systems Reduction in administrative processing time. Percentage of administrative services delivered online
5. Strengthen institutional strategic planning and policy implementation	Institutional Strategy Development Programme Strategic Planning Support Initiative	Percentage of universities with updated strategic plans. Annual implementation reports produced. Percentage of strategic targets achieved
6. Improve financial governance and accountability	Financial Management Modernization Programme Digital Financial Reporting Initiative	Percentage of HE is using integrated financial management systems Timely publication of audited financial statements. Reduction in audit queries Growth in internally generated revenue (IGR)
7. Establish enterprise risk management systems	University Risk Management Programme. Business Continuity and Disaster Recovery Initiative	Number of HE with enterprise risk management frameworks. Annual institutional risk assessments completed Business continuity plans developed and tested

8. Modernize procurement and asset management systems	Electronic Procurement (e-Procurement) Programme Digital Asset Management Initiative	Percentage of procurement conducted electronically. Procurement cycle time reduced. Percentage of institutional assets digitally registered and tracked
9. Strengthen internal quality assurance and governance compliance	Institutional Quality Assurance Enhancement Programme Governance Compliance Monitoring Programme	Percentage of universities with functional Internal Quality Assurance Units Governance compliance index Accreditation success rate
10. Enhance leadership development and succession planning	University Leadership Academy Emerging Leaders Fellowship Programme	Number of HE leaders trained annually Succession plans developed. Percentage of leadership positions filled through transparent processes
11. Promote evidence-based decision-making through institutional data systems	Higher Education Data Analytics Programme Institutional Intelligence Dashboard Initiative	Universities operating institutional data dashboards • Annual institutional data reports published • Percentage of management decisions supported by institutional data
12. Strengthen stakeholder engagement and shared governance	HE Stakeholder Engagement Programme Student and Alumni Participation Initiative	Number of stakeholder consultation forums held annually. Stakeholder satisfaction index. Industry participation in university governance structures
13. Improve transparency, ethics and anti-corruption systems	Institutional Integrity Programme, HE Ethics and Compliance Initiative	Ethics policies adopted. Number of corruption complaints resolved Transparency index improvement Compliance audits completed
14. Enhance university autonomy with strengthened accountability	HE Autonomy Strengthening Programme Accountability and Institutional Performance Initiative	Institutional autonomy index Compliance with regulatory requirements, Flexibility in curriculum development, recruitment, research priorities, and partnership, Reduction in administrative bottlenecks, Reduction in excessive governmental bureaucratic control over institutional operations,
15. Strengthen regulatory coordination among oversight agencies	Higher Education Governance Coordination Programme Joint Regulatory Harmonization Initiative	Joint policy meetings conducted annually Harmonized regulatory guidelines developed Reduced duplication of regulatory processes
16. Promote international benchmarking and governance excellence	Global HE Governance Benchmarking Programme International HE Partnership Initiative	Number of HE benchmarked internationally international governance partnerships established. Improvement in global university governance rankings
17. Strengthen digital records management and cybersecurity	Digital Records Management Programme. HE Cybersecurity Enhancement Programme	Percentage of institutional records digitized Number of cybersecurity audits conducted Reduction in cybersecurity incidents
18. Establish a National Higher Education Governance Observatory	Governance Monitoring and Evaluation Programme. Higher Education Governance Performance Dashboard	National governance dashboard operational. Annual governance performance reports published Governance performance index developed

Responsibilities

A well-structured responsibility matrix presented in Table 6.3 provides clarity on leadership, accountability, and collaboration by identifying the institutions responsible for driving each strategic activity while specifying supporting agencies and the appropriate level of implementation. This approach minimizes duplication of effort, strengthens coordination among stakeholders, and promotes efficient use of resources.

Table 6.3: Responsibility matrix for Governance and Modernization of University Governance System

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level (National, State, Institutional)
Develop and implement the National University Governance Reform Framework	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, State Ministries of Education	National
Review and harmonize higher education governance policies and regulations	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, National Assembly Committees on Education	National
Strengthen Governing Councils and Senate effectiveness	National Universities Commission	University Governing Councils, University Senates, Committee of Vice-Chancellors, State Governments	National, Institutional
Introduce performance-based management and leadership accountability	National Universities Commission	Federal Ministry of Education, Governing Councils, Vice-Chancellors, Rectors, Provosts	National, Institutional
Establish institutional performance monitoring and benchmarking systems	National Universities Commission	National Board for Technical Education, National Commission for Colleges of Education, National Bureau of Statistics, Universities	National, Institutional
Digitize university governance and administration	National Information Technology Development Agency	Federal Ministry of Education, National Universities Commission, Universities, ICT Units, Galaxy Backbone Ltd.	National, Institutional
Deploy integrated University Management Information Systems (UMIS)	Universities	National Universities Commission, National Information Technology Development Agency, ICT vendors, Tertiary Education Trust Fund	Institutional
Strengthen financial governance and accountability systems	Universities	Governing Councils, Federal Ministry of Education, Office of the Accountant-General of the Federation, Tertiary Education Trust Fund	Institutional
Modernize procurement and asset management systems	Universities	Bureau of Public Procurement, Governing Councils, Internal Audit Units	Institutional
Establish enterprise risk management and business continuity systems	Universities	Governing Councils, Internal Audit Units, Federal Ministry of Education	Institutional
Strengthen internal quality assurance and governance compliance	National Universities Commission	Universities, National Board for Technical Education, National Commission for Colleges of Education, Professional Regulatory Bodies	National, Institutional

Develop leadership and succession planning programmes	National Universities Commission	Committee of Vice-Chancellors, Universities, Tertiary Education Trust Fund, Development Partners	National, Institutional
Promote evidence-based planning through institutional data systems	National Universities Commission	National Bureau of Statistics, National Information Technology Development Agency, Universities	National, Institutional
Establish higher education governance data observatory and dashboards	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, National Bureau of Statistics	National
Promote stakeholder engagement and shared governance	Universities	Governing Councils, Student Unions, Staff Unions, Alumni Associations, Industry Partners, Civil Society Organizations	Institutional
Strengthen ethics, integrity, transparency and anti-corruption systems	Universities	Independent Corrupt Practices Commission, Economic and Financial Crimes Commission, Code of Conduct Bureau, Governing Councils	National, Institutional
Promote university autonomy with strengthened accountability	Federal Ministry of Education	National Universities Commission, Governing Councils, National Assembly	National
Strengthen regulatory coordination among higher education agencies	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, Joint Admissions and Matriculation Board	National
Promote international benchmarking and adoption of global governance standards	National Universities Commission	Universities, Federal Ministry of Education, International Development Partners, International University Associations	National, Institutional
Strengthen digital records management and cybersecurity	National Information Technology Development Agency	Universities, Office of the National Security Adviser, Galaxy Backbone Ltd., ICT Units	National, Institutional
Monitor, evaluate and report governance reform implementation	Federal Ministry of Education	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, Tertiary Education Trust Fund, Universities	National, State, Institutional

Key Performance Indicators

The Key Performance Indicators (KPIs) provide a measurable framework for tracking the implementation and impact of governance reforms under Nigeria's STEM Transformation Strategy. They assess progress in institutional governance, digital transformation, leadership effectiveness, financial accountability, quality assurance, stakeholder engagement, and operational efficiency. The baseline reflects the current status (2025/2026 estimate), while the

short-, medium-, and long-term targets provide progressive milestones toward achieving a modern, transparent, and globally competitive university governance system by 2035.

Table 6.4: Key Performance Indicators (KPIs) for Governance and Modernization of University Governance System

Key Performance Indicator (KPI)	Baseline (2025/26)	Short-Term Target (2026–2027)	Medium-Term Target (2028–2030)	Long-Term Target (2031–2035)
Institutions adopting the National Governance Reform Framework	<10%	40%	80%	100%
Universities with updated governance statutes and policies	25%	50%	80%	100%
Governing Councils meeting governance performance standards	30%	60%	85%	100%
Principal officers completing certified governance and leadership training	20%	60%	90%	100%
Institutions implementing performance contracts for senior management	5%	30%	70%	100%
Institutions publishing annual governance and performance reports	20%	50%	80%	100%
Institutions using integrated University Management Information Systems (UMIS)	25%	50%	80%	100%
Administrative services delivered digitally	20%	50%	80%	95%
Institutions implementing electronic procurement systems	15%	40%	75%	100%
Institutions operating enterprise risk management systems	10%	40%	80%	100%
Institutions with functional Internal Quality Assurance Units	45%	70%	90%	100%
Institutions producing annual institutional performance scorecards	10%	50%	80%	100%
Institutions using institutional data dashboards for decision-making	10%	40%	75%	100%
Institutions publishing audited financial statements within statutory timelines	35%	60%	85%	100%
Institutions with diversified revenue streams beyond government funding	20%	40%	70%	90%
Institutions with digitized records management systems	20%	50%	85%	100%

Institutions conducting annual governance self-assessments	10%	50%	80%	100%
Institutions implementing cybersecurity policies and annual security audits	15%	50%	85%	100%
Stakeholder satisfaction with institutional governance	50%	65%	80%	≥90%
Institutions with active industry, alumni, and community representation in governance	30%	50%	80%	100%
Average administrative processing time for key approvals	20 working days	15 days	10 days	≤5 days
Procurement processing cycle	90 days	60 days	40 days	≤30 days
Annual institutional compliance with regulatory requirements	60%	75%	90%	100%
Institutions with functional business continuity and disaster recovery plans	10%	40%	80%	100%
National Higher Education Governance Dashboard operational	Not available	Design completed	Operational	Fully integrated with all institutions
Institutions participating in international governance benchmarking	10%	30%	60%	90%
Universities improving in recognized global rankings	Limited improvement	20 universities	40 universities	60+ universities
Governance-related audit queries resolved within one year	40%	70%	90%	≥95%
Annual institutional strategic plan implementation rate	40%	65%	85%	≥95%
Institutions achieving full governance compliance rating	20%	50%	80%	100%

Note: Baseline values are indicative national estimates and should be validated through a comprehensive governance audit led by the **Federal Ministry of Education (FME)**, **National Universities Commission (NUC)**, **National Board for Technical Education (NBTE)**, and **National Commission for Colleges of Education (NCCE)** before implementation

Timelines

The implementation of the Governance and Modernization of University Governance System will be undertaken in four sequential phases over a ten-year period. This phased approach enables the gradual introduction of governance reforms, institutional capacity building, digital transformation, and continuous performance improvement while allowing sufficient time for stakeholder engagement, policy harmonization, and monitoring and evaluation. Each phase builds upon the achievements of the previous phase to ensure sustainable and system-wide transformation across Nigeria's higher education institutions.

Table 6.5: Implementation Timeline for Governance and Modernization of University Governance System

Phase	Timeline	Key Activities
Phase I: Policy Reform and Foundation Building	2026–2027 (Short Term)	Develop the National University Governance Reform Framework. Review and harmonize governance policies and regulations. Establish national governance steering and coordination committees. Conduct governance needs assessments across tertiary institutions. Develop institutional strategic plans and governance guidelines. Design performance management and accountability frameworks. Initiate leadership and governance training for Governing Councils and principal officers. Develop digital governance architecture and implementation standards.
Phase II: Institutional Modernization and Digital Transformation	2028–2030 (Medium Term)	Deploy integrated University Management Information Systems (UMIS). Introduce performance contracts and institutional scorecards. Digitize finance, procurement, HR, research, and student administration. Strengthen quality assurance, internal audit, and enterprise risk management. Implement e-governance and digital records management systems. Expand leadership development and succession planning programmes. Strengthen stakeholder engagement mechanisms.
Phase III: System Integration and Performance Optimization	2031–2033 (Medium–Long Term)	Scale governance reforms to all public tertiary institutions and encourage adoption by private institutions. Integrate institutional data with national higher education information systems. Strengthen governance benchmarking and performance monitoring. Expand international governance partnerships and peer learning. Enhance financial sustainability and resource mobilization. Conduct mid-term governance evaluation and policy refinement.
Phase IV: Sustainability, Innovation and Global Competitiveness	2034–2035 (Long Term)	Institutionalize continuous governance improvement. Conduct comprehensive impact evaluation. Update governance policies based on emerging trends. Strengthen innovation-driven leadership and organizational resilience. Promote global accreditation, rankings, and governance excellence. Mainstream artificial intelligence, data analytics, and advanced digital governance tools. Develop the next-generation governance reform strategy.

Expected Outcomes

The Governance and Modernization of University Governance System component is expected to transform Nigeria's higher education institutions into autonomous, transparent, digitally enabled, and performance-driven organizations capable of delivering high-quality STEM education, research, and innovation. By strengthening institutional leadership, improving accountability, modernizing administrative systems, and fostering evidence-based decision-making, the strategy will create a governance ecosystem that supports institutional excellence, operational efficiency, financial sustainability, and global competitiveness. These outcomes will contribute significantly to achieving the broader objectives of Nigeria's STEM Transformation Strategy and the country's transition to a knowledge-based economy.

Table 6.6: Expected Outcomes for Governance and Modernization of University Governance System

Implementation Phase	Expected Outcomes
Phase I: Policy Reform and Foundation Building (2026–2027)	National University Governance Reform Framework developed and adopted. Governance policies, regulations, and institutional statutes reviewed and harmonized. Governance structures and institutional responsibilities clearly defined. Governing Councils, Senates, and principal officers trained in modern university governance and leadership. Governance baseline assessments completed across tertiary institutions. Institutional strategic plans aligned with the national STEM Transformation Strategy. Digital governance architecture and implementation standards established. National governance coordination and monitoring mechanisms operational.
Phase II: Institutional Modernization and Digital Transformation (2028–2030)	Integrated digital governance and University Management Information Systems (UMIS) operational in most tertiary institutions. Administrative, financial, procurement, human resource, and academic management processes digitized. Performance contracts and institutional scorecards implemented for university leadership. Internal quality assurance, enterprise risk management, and internal audit systems strengthened. Institutional decision-making increasingly based on reliable data and analytics. Administrative efficiency improved through automation and reduced processing times. Financial management, procurement, and reporting become more transparent and accountable.
Phase III: System Integration and Performance Optimization (2031–2033)	Governance reforms institutionalized across universities, polytechnics, and colleges of education. National higher education governance performance dashboard fully operational. Universities demonstrate measurable improvements in governance effectiveness and service delivery. Stronger institutional autonomy balanced by improved accountability and regulatory compliance. Enhanced collaboration among government, academia, industry, and development partners. Improved financial sustainability through diversified revenue generation and prudent resource management. Governance benchmarking and peer-learning mechanisms established across institutions.
Phase IV: Sustainability and Global Competitiveness (2034–2035)	Modern governance practices fully embedded across Nigeria's higher education institutions. Digitally enabled, transparent, accountable, and resilient governance systems sustained. Nigerian universities, polytechnics, and colleges of education recognized for governance excellence within Africa and globally. Institutional leadership characterized by professionalism, ethical conduct, and continuous improvement. Governance systems support world-class STEM education, research, innovation, entrepreneurship, and commercialization. Universities achieve greater global competitiveness, improved international rankings, and stronger research collaborations. Governance reforms become self-sustaining through continuous monitoring, evaluation, and policy refinement.

6.2 Strengthening Quality Assurance

Introduction

Strengthening quality assurance is a critical pillar of Nigeria's STEM Transformation Strategy for Higher Education, ensuring that teaching, research, innovation, and community engagement consistently meet national priorities and international standards. As Nigeria seeks to develop a globally competitive knowledge economy, robust quality assurance systems are essential for improving institutional performance, graduate employability, research excellence, and public confidence in higher education institutions. Quality assurance extends beyond

accreditation to encompass continuous improvement in governance, curriculum relevance, academic standards, research integrity, digital learning, infrastructure, staff development, student support services, and industry engagement.

Within Nigeria's STEM Transformation Strategy, strengthening quality assurance involves modernizing accreditation processes, establishing digital quality assurance platforms, developing national STEM quality standards, enhancing institutional internal quality assurance units, strengthening external evaluation mechanisms, promoting international accreditation, improving data management and performance monitoring, and fostering a culture of continuous improvement across universities, polytechnics, colleges of education, and specialized institutions. These reforms will enable Nigerian institutions to produce graduates with globally relevant competencies, enhance research productivity, attract international collaborations, and improve the overall competitiveness of the country's higher education system.

Vison

‘To establish a globally recognized, inclusive, technology-enabled, and continuously improving quality assurance system that ensures excellence in STEM teaching, research, innovation, governance, and graduate outcomes across Nigeria's higher education institutions.”

Mision

“To strengthen and modernize quality assurance systems by implementing evidence-based standards, digital quality management, continuous accreditation, institutional capacity development, stakeholder engagement, and performance-driven monitoring that enhance teaching quality, research excellence, innovation, and graduate employability across Nigeria's STEM higher education institutions”.

Strategic Goals

The strategic goals for the **Strengthening Quality Assurance** component of Nigeria's STEM Transformation Strategy are designed to establish a robust, transparent, technology-enabled, and internationally benchmarked quality assurance system that promotes continuous improvement across teaching, research, innovation, governance, and institutional performance Table 6.7. The goals support the mandates of the National Universities Commission (NUC), National Board for Technical Education (NBTE), National Commission for Colleges of Education (NCCE), and the Federal Ministry of Education.

Table 6.7: strategic Goals and Desired Expectations for Strengthening Quality Assurance

Strategic Goal	Desired Expectations
1. Modernize the National Quality Assurance Framework for STEM Higher Education	Harmonized, competency-based, outcome-focused, and internationally benchmarked quality assurance standards are adopted across universities, polytechnics, colleges of education, and specialized institutions.
2. Strengthen Internal Quality Assurance (IQA) Systems	Every institution establishes functional Internal Quality Assurance Units with clear policies, regular self-assessment, performance monitoring, and continuous improvement mechanisms.

3. Enhance Accreditation and Programme Review Processes	Accreditation becomes transparent, evidence-based, technology-enabled, risk-informed, and focused on educational outcomes rather than compliance alone.
4. Improve Quality of Teaching, Learning, and Curriculum Delivery	STEM curricula are regularly reviewed to reflect emerging technologies, industry needs, entrepreneurship, sustainability, digital competencies, and competency-based learning. Teaching quality and student learning outcomes improve significantly.
5. Promote Research Quality, Integrity, and Innovation Excellence	Institutions strengthen research governance, ethics, reproducibility, innovation management, commercialization, and international research collaborations, leading to increased research quality and societal impact.
6. Strengthen Digital Quality Assurance and Data Management	Integrated digital quality assurance platforms provide real-time monitoring of institutional performance, accreditation status, learning outcomes, research indicators, and institutional compliance.
7. Build Capacity of Academic, Administrative, and Technical Staff	Academic leaders, lecturers, quality assurance officers, laboratory personnel, and administrators receive continuous professional development in quality management, pedagogy, digital learning, research supervision, and assessment.
8. Strengthen Graduate Employability and Industry Relevance	STEM graduates possess industry-relevant competencies, practical skills, entrepreneurial capabilities, and digital literacy, resulting in improved graduate employability and employer satisfaction.
9. Promote International Benchmarking and Global Competitiveness	Nigerian institutions increasingly achieve international accreditation, improve global rankings, participate in academic mobility programmes, and expand partnerships with leading global institutions.
10. Institutionalize a Culture of Continuous Quality Improvement	Quality assurance becomes embedded in institutional governance, strategic planning, budgeting, performance management, and decision-making, fostering accountability, transparency, and continuous improvement.
11. Strengthen Student-Centred Quality Assurance	Students actively participate in quality assurance processes through feedback systems, graduate tracer studies, student satisfaction surveys, and representation in institutional quality committees.
12. Improve Monitoring, Evaluation, and Accountability	A national performance monitoring framework with measurable indicators, annual institutional quality reports, benchmarking, and public performance dashboards supports evidence-based policy and institutional improvement.

Strategic Activities

The activities and programmes under the **Strengthening Quality Assurance** component are designed to operationalize the strategic goals through coordinated actions at the national, state, and institutional levels. They focus on modernizing quality assurance systems, enhancing accreditation processes, improving teaching and learning, strengthening research quality, and promoting continuous institutional improvement.

Table 6.8: Activities, Programmes and Key Performance Indicators (KPIs) for Strengthening Quality Assurance

Strategic Activity	Programme/Intervention	Key Performance Indicators (KPIs)
1. Review and modernize the National Quality Assurance Framework for STEM Programme	National STEM Quality Assurance Reform Programme to reflect emerging technologies, hybrid and digital learning systems, innovation and entrepreneurship competencies. Industry relevance, research productivity and interdisciplinary STEM programmes	Revised national QA framework approved. National STEM QA standards developed. Percentage of institutions adopting revised standards

2. Harmonize accreditation standards across higher education institutions	Harmonized Accreditation and Standards Programme	Common accreditation guidelines developed. Number of programmes accredited using harmonized standards Reduction in accreditation inconsistencies
3. Strengthen Internal Quality Assurance (IQA) Units	Institutional Quality Assurance Strengthening Initiative	Percentage of institutions with functional IQA Units Number of annual institutional self-assessment reports Annual quality improvement plans implemented
4. Digitalize quality assurance processes	National Digital Quality Assurance Platform. National Digital Learning Standards; Digital Pedagogy Certification, Quality Assurance for Educational Technology	National QA information system operational Percentage of accreditation processes conducted digitally Institutional quality dashboards established
5. Periodically review STEM curricula	Curriculum Renewal and Outcome-Based Education Programme	Percentage of STEM programmes reviewed every 3–5 years. Number of programmes adopting competency-based curricula. Employer satisfaction with curriculum relevance
6. Improve teaching quality and pedagogy	STEM Teaching Excellence Programme	Number of academic staff trained annually. Percentage of lecturers certified in modern pedagogy and digital teaching. Improvement in student teaching evaluation scores
7. Strengthen assessment and examination quality	Assessment and Academic Standards Enhancement Programme	Standardized assessment guidelines implemented. Reduction in examination irregularities Percentage of programmes using outcome-based assessment
8. Improve laboratory and practical quality standards	STEM Laboratory Quality Improvement Programme	Percentage of laboratories meeting minimum standards. Number of laboratories accredited/certified. Student-to-equipment ratio improved
9. Strengthen research quality and integrity	National Research Quality and Integrity Programme. Research Quality Assurance Framework. Research Productivity Standards, Centres of Excellence quality assurance Evaluation Systems	Institutional research ethics committees strengthened. Number of institutions adopting research integrity policies. Increase in high-impact publications and citations
10. Promote continuous professional development	Quality Assurance Capacity Development Programme	Number of QA officers trained. Number of institutional leaders completing QA leadership programmes • Percentage of institutions implementing annual staff development plans
11. Establish graduate tracer and employer feedback systems in STEM courses	Graduate Employability Monitoring Programme	National graduate tracer system operational. Graduate employment rate within 12 months Employer satisfaction index
12. Strengthen student participation in quality assurance	Student Engagement in Quality Programme	Student representation on QA committees Annual student satisfaction surveys conducted

		Percentage of institutions acting on student feedback
13. Promote international accreditation and benchmarking	Global Quality Benchmarking Initiative Alignment; International Collaboration and Knowledge Exchange initiatives; Benchmarking and Ranking Systems	Number of programmes obtaining international accreditation. Number of international benchmarking exercises completed Improvement in institutional ranking indicators
14. Strengthen monitoring, evaluation and institutional performance reporting	National STEM Quality Performance Monitoring Programme to include graduate skills competencies, industry readiness, innovation capability, problem-solving, employability outcomes, innovation capability	Annual institutional quality reports published. National QA performance dashboard operational. Percentage of institutions meeting annual quality targets
15. Promote quality culture and institutional excellence	Quality Culture and Excellence Awards Programme	Annual quality excellence awards instituted. Number of institutions receiving quality certifications Improvement in institutional quality maturity index
Industry Participation in Quality Assurance	Industry-Led Curriculum Review; Employer Feedback Mechanisms; Professional Accreditation Partnerships	Annual Institutions review reports; Number of employer feedbacks; Number of STEM programmes undertaking professional accreditation
16. Strengthen governance and accountability for quality assurance	Higher Education Quality Governance Programme	Institutional QA policies approved. Annual governance compliance assessments completed. Percentage of institutions implementing quality improvement recommendations

Responsibilities

The responsibility matrix presented in Table 6.9 adopts a **multi-level governance approach**, recognizing that quality assurance is a shared responsibility among national regulatory agencies, state governments, and individual higher education institutions. At the national level, the Federal Ministry of Education provides overall policy direction and coordination, while the National Universities Commission (NUC), National Board for Technical Education (NBTE), and National Commission for Colleges of Education (NCCE) lead the development of standards, accreditation, quality monitoring, and regulatory oversight. The Tertiary Education Trust Fund (TETFund) supports implementation through strategic investments in infrastructure, research, staff development, and digital transformation. At the state level, Ministries of Education facilitate implementation in state-owned institutions by aligning state policies with national quality assurance frameworks, mobilizing resources, and supporting compliance with established standards. At the institutional level, governing councils, vice-chancellors, rectors, provosts, Internal Quality Assurance Units, academic departments, and research offices are responsible for embedding a culture of continuous quality improvement through self-assessment, performance monitoring, curriculum enhancement, research quality management, and stakeholder engagement.

Table 6.9: Responsibility Matrix for Strengthening Quality Assurance

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level (National, State, Institutional)
Review and modernize the National Quality Assurance Framework	Federal Ministry of Education, National Universities Commission	National Board for Technical Education, National Commission for Colleges of Education, Professional Bodies, Universities	National
Harmonize accreditation standards across tertiary institutions	National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education	Professional Regulatory Councils, Industry Associations, State Ministries of Education	National
Establish and strengthen Internal Quality Assurance (IQA) Units	Universities, Polytechnics, Colleges of Education	NUC, NBTE, NCCE, Governing Councils	Institutional
Develop and deploy a National Digital Quality Assurance Platform	Federal Ministry of Education	NUC, NBTE, NCCE, Tertiary Education Trust Fund (TETFund), ICT Service Providers	National
Strengthen institutional quality management systems	Governing Councils and Institutional Management	Internal Quality Assurance Units, Academic Planning Units, TETFund	Institutional
Review and modernize STEM curricula	NUC, NBTE, NCCE	Professional Bodies, Industry Partners, Universities, Polytechnics, Colleges of Education	National, Institutional
Promote outcome-based and competency-based education	NUC, NBTE, NCCE	Institutions, Industry Partners, Professional Accreditation Bodies	National, Institutional
Strengthen teaching quality through academic staff development	TETFund, Institutional Management	NUC, NBTE, NCCE, Centres for Teaching and Learning	National, Institutional
Enhance laboratory quality standards and safety compliance	TETFund, Institutional Management	NUC, NBTE, NCCE, Professional Scientific Associations	National, Institutional
Strengthen research quality, ethics, and integrity systems	Institutional Research Offices	National Research Fund, TETFund, Research Ethics Committees	Institutional
Establish national graduate tracer and employer feedback systems	Federal Ministry of Education	NUC, NBTE, NCCE, National Bureau of Statistics, Employers' Associations	National, Institutional
Promote student participation in quality assurance	Institutional Management	Student Unions, IQA Units, Governing Councils	Institutional
Develop institutional performance dashboards	Federal Ministry of Education	NUC, NBTE, NCCE, TETFund, ICT Providers	National, Institutional
Conduct periodic institutional self-assessment and external reviews	Institutional Quality Assurance Units	NUC, NBTE, NCCE, External Peer Review Teams	Institutional

Promote international accreditation and benchmarking	NUC, NBTE, NCCE	International Accreditation Agencies, Universities, Development Partners	National, Institutional
Build capacity of quality assurance professionals	TETFund	NUC, NBTE, NCCE, Universities, International Development Partners	National, Institutional
Establish annual national quality audits and performance reporting	Federal Ministry of Education	NUC, NBTE, NCCE, National Bureau of Statistics, Institutions	National
Develop a National STEM Quality Performance Dashboard	Federal Ministry of Education	TETFund, NUC, NBTE, NCCE, ICT Partners	National
Institutionalize quality culture through incentive and recognition programmes	Institutional Governing Councils	Federal Ministry of Education, NUC, NBTE, NCCE, Professional Associations	Institutional
Strengthen monitoring, evaluation, and continuous improvement mechanisms	Federal Ministry of Education	NUC, NBTE, NCCE, TETFund, State Ministries of Education, Institutions	National, State, Institutional

Key Performance Indicators

The Key Performance Indicators (KPIs) for the **Strengthening Quality Assurance** component provide a results-based framework for measuring progress toward achieving excellence, accountability, and continuous improvement in Nigeria's STEM higher education system. The indicators are aligned with the strategic objectives of the Nigeria STEM Transformation Strategy and the quality assurance mandates of the Federal Ministry of Education, National Universities Commission (NUC), National Board for Technical Education (NBTE), National Commission for Colleges of Education (NCCE), and Tertiary Education Trust Fund (TETFund).

Table 6.10: Key Performance Indicators (KPIs) for Strengthening Quality Assurance

KPI	Baseline (2026)	Short-Term Target (2027–2029)	Medium-Term Target (2030–2032)	Long-Term Target (2033–2035)
Institutions with functional Internal Quality Assurance (IQA) Units	55%	80%	95%	100%
STEM programmes with full accreditation	65%	80%	90%	100%
Institutions implementing digital quality assurance systems	20%	60%	85%	100%
National Digital Quality Assurance Platform operational	Not available	Platform developed and deployed	Fully integrated nationwide	AI-enabled national QA ecosystem fully operational
STEM programmes reviewed using Outcome-Based Education (OBE)	25%	60%	85%	100%

Institutions conducting annual self-assessment	40%	75%	90%	100%
Institutions publishing annual quality assurance reports	30%	70%	90%	100%
Academic staff trained in quality assurance, pedagogy and assessment	20%	50%	80%	100%
Institutions with functional research ethics and integrity systems	45%	70%	90%	100%
Institutions implementing graduate tracer studies	15%	50%	80%	100%
Institutions conducting annual employer satisfaction surveys	10%	45%	75%	100%
Student satisfaction with teaching and learning	60%	70%	80%	90%
Graduate employment within 12 months of graduation	45%	55%	70%	85%
STEM laboratories meeting national quality standards	35%	60%	80%	95%
Laboratories accredited to recognized standards	15%	35%	60%	85%
Institutions using institutional performance dashboards	10%	50%	80%	100%
Accreditation processes conducted digitally	15%	60%	90%	100%
Quality assurance officers receiving annual professional development	20%	60%	85%	100%
Institutions implementing annual quality improvement plans	35%	70%	90%	100%
Programmes with active industry participation in curriculum review	30%	60%	85%	100%
Institutions participating in international benchmarking exercises	15%	40%	70%	90%
STEM programmes with international accreditation	5%	15%	35%	60%
Institutions improving national/international ranking positions	20%	40%	70%	90%
Institutions operating comprehensive student feedback systems	40%	75%	90%	100%
Institutional quality improvement recommendations implemented annually	45%	75%	90%	100%

Timelines

The implementation of the **Strengthening Quality Assurance** component will be undertaken in three sequential phases over a ten-year period (2026–2035) (Table 6.10). The phased approach enables the gradual strengthening of policies, institutional capacities, digital systems, accreditation processes, and continuous quality improvement mechanisms while ensuring sustainable implementation across universities, polytechnics, colleges of education, and specialized institutions. Each phase builds upon the achievements of the previous phase,

progressing from policy reforms and capacity development to nationwide implementation and ultimately to international competitiveness and institutional excellence.

Table 6.11: Implementation Timeline in Phases for Strengthening Quality Assurance

Phase	Timeline	Major Activities
Phase I: Foundation and System Strengthening	**2026–2028**	Review and update the National Quality Assurance Framework. Harmonize accreditation standards across universities, polytechnics, and colleges of education. Establish or strengthen Internal Quality Assurance (IQA) Units. Develop the National Digital Quality Assurance Platform. Conduct baseline quality assessment of STEM institutions. Train quality assurance officers, academic leaders, and programme coordinators. Begin curriculum review using Outcome-Based Education (OBE). Develop national quality assurance guidelines, manuals, and performance indicators.
Phase II: Expansion and Institutional Integration	**2029–2032**	Scale up implementation of digital quality assurance systems. Conduct nationwide programme accreditation using revised standards. Strengthen research quality, ethics, and integrity systems. Upgrade laboratory quality and safety standards. Institutionalize annual self-assessments and quality improvement plans. Launch graduate tracer studies and employer satisfaction surveys. Expand staff development programmes. Strengthen monitoring and evaluation systems.
Phase III: Consolidation, Innovation and Global Competitiveness	**2033–2035**	Achieve universal compliance with national quality standards.• Expand international accreditation and global benchmarking. Integrate artificial intelligence and predictive analytics into quality assurance systems. Institutionalize continuous quality improvement and performance-based management. Conduct comprehensive impact evaluation of the strategy. Review and update quality assurance policies based on lessons learned. Promote institutional excellence through national quality awards and international partnerships.

6.3 Expected Outputs by Phase

Phase I: Foundation and Capacity Building (2026–2028)

1. National Quality Assurance Framework revised and operational.
2. Harmonized accreditation standards adopted.
3. Internal Quality Assurance Units established in most institutions.
4. National Digital Quality Assurance Platform launched.
5. Baseline assessment and national quality indicators completed.
6. Capacity-building programmes delivered for quality assurance professionals.

Phase II: Institutional Strengthening (2029–2032)

1. Revised accreditation system fully operational.
2. Digital quality assurance adopted across most institutions.
3. Outcome-Based Education implemented across STEM programmes.
4. Annual quality reporting institutionalized.
5. Graduate tracer studies and employer feedback systems operational.
6. Measurable improvements in teaching quality, research integrity, and laboratory standards.

Phase III: Excellence and Sustainability (2033–2035)

1. Universal compliance with national quality assurance standards.
2. Widespread international accreditation of STEM programmes.
3. AI-enabled, data-driven quality management system fully operational.
4. Nigerian STEM institutions demonstrate improved regional and global competitiveness.
5. Sustainable culture of continuous quality improvement embedded across all higher education institutions.
6. Comprehensive evaluation informs the next generation of higher education quality reforms.

6.4 Gender Strategy

Introduction

Gender equality is a fundamental driver of educational excellence, scientific innovation, and sustainable national development. A **Gender Strategy** provides a structured framework for ensuring that women, men, girls, and boys have equitable opportunities to access, participate in, contribute to, and benefit from higher education, research, innovation, and leadership. Within Nigeria's STEM Transformation Strategy for Higher Education, the Gender Strategy seeks to mainstream gender considerations across policies, governance, teaching, research, innovation, financing, infrastructure, and institutional culture to eliminate systemic barriers and promote inclusive participation. According to UNESCO, achieving gender equality in STEM is not only a matter of social justice but also a prerequisite for scientific excellence, innovation, and economic competitiveness.[96]

Despite notable progress in expanding access to higher education, significant gender disparities persist in STEM disciplines worldwide and in Nigeria. Women remain underrepresented in engineering, computing, physical sciences, and technology-related careers, while also facing challenges in research funding, academic promotion, leadership positions, and commercialization of research outputs.[97] These disparities are often reinforced by socio-cultural norms, unconscious bias, inadequate mentorship, limited access to professional networks, work-life balance challenges, and institutional practices that do not adequately support diversity and inclusion.[98]

For Nigeria, integrating a Gender Strategy into the STEM Transformation Agenda aligns with the objectives of the Federal Ministry of Women Affairs's **National Gender Policy** (2021), which advocates equal opportunities, inclusive participation, and gender-responsive governance across all sectors. It also supports the country's commitment to the **Sustainable Development Goals (SDGs)**, particularly Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and

[96] UNESCO. (2017). Cracking the Code: Girls' and Women's Education in STEM. Paris: UNESCO.
[97] UNESCO. (2017). Cracking the Code: Girls' and Women's Education in STEM. Paris: UNESCO.
[98] UN Women. (2022). Progress on the Sustainable Development Goals: The Gender Snapshot. New York: UN Women.

Infrastructure), and Goal 10 (Reduced Inequalities).[99] Furthermore, the strategy contributes to the aspirations of the African Union's **Agenda 2063**, which recognizes gender equality as a cornerstone of Africa's socio-economic transformation.

The Gender Strategy adopts a holistic approach that extends beyond increasing female enrolment in STEM programmes. It seeks to build an enabling ecosystem that supports equitable recruitment, retention, career progression, leadership development, research participation, entrepreneurship, and innovation for women and other underrepresented groups. Strategic interventions include gender-responsive policies, targeted scholarships and fellowships, mentorship programmes, leadership development initiatives, family-friendly workplace policies, prevention of sexual harassment and gender-based violence, and institutional mechanisms that promote accountability and inclusion. Research has consistently shown that diverse research teams produce more innovative solutions, generate higher-quality scientific outputs, and improve institutional performance.[100]

A key pillar of the strategy is the institutionalization of gender-responsive planning, budgeting, monitoring, and evaluation. This includes the collection and analysis of sex-disaggregated data, establishment of measurable gender indicators, regular institutional gender audits, and evidence-based decision-making. Such mechanisms enable higher education institutions to monitor progress, identify persistent gaps, and strengthen accountability while ensuring that investments in STEM contribute to inclusive national development.[101] By embedding gender equality across every aspect of Nigeria's STEM transformation agenda, the strategy aims to unlock the full potential of the country's human capital, strengthen research and innovation ecosystems, and enhance Nigeria's global competitiveness in science, technology, and knowledge-based industries.

Vision

"To create an inclusive, equitable, and gender-responsive higher education and STEM ecosystem in Nigeria where women and men have equal opportunities to learn, lead, innovate, conduct research, and contribute to national development and global competitiveness"

Mision

"To mainstream gender equality and social inclusion across higher education policies, governance, teaching, research, innovation, infrastructure, financing, and institutional practices through evidence-based policies, targeted investments, capacity building, strategic partnerships, and robust accountability mechanisms that empower women and other underrepresented groups to excel in STEM".

[99] United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. New York: United Nations.
[100] UNESCO. (2021). UNESCO Recommendation on Open Science. Paris: UNESCO.
[101] Organisation for Economic Co-operation and Development. (2017). The Pursuit of Gender Equality: An Uphill Battle. Paris: OECD Publishing.

Strategic goals

The strategic goals of the Gender Strategy are designed to mainstream gender equality across all aspects of Nigeria's higher education and STEM ecosystem (Table 6.11). These goals seek to increase equitable participation, strengthen institutional capacity, promote inclusive leadership, eliminate gender-related barriers, and ensure that STEM education, research, innovation, and entrepreneurship contribute to inclusive national development. Collectively, they support the implementation of Nigeria's National Gender Policy, the Sustainable Development Goals, and the African Union Agenda 2063.

Table 6.12: Strategic Goals and Desired Expectations for the Gender Strategy in Nigeria's STEM Transformation Strategy for Higher Education

Strategic Goal	Desired Expectations
1. Expand equitable access and participation in STEM education	Increased enrolment, retention, completion, and transition of women and girls into undergraduate, postgraduate, and technical STEM programmes across all regions of Nigeria.
2. Strengthen recruitment, retention, and career progression of female STEM academics and researchers	Higher representation of women in academic positions, research careers, promotions, professorial ranks, and leadership positions within higher education institutions.
3. Institutionalize gender-responsive governance and policies	All higher education institutions adopt and implement gender-responsive policies, strategic plans, budgeting frameworks, and accountability mechanisms that promote equality and inclusion.
4. Promote gender-inclusive research, innovation, and entrepreneurship	Increased participation of women in competitive research grants, patents, technology commercialization, startups, innovation hubs, and industry partnerships.
5. Develop leadership and mentorship opportunities for women in STEM	Establish sustainable mentorship, coaching, networking, and leadership development programmes that prepare women for senior academic and institutional leadership roles.
6. Create safe, inclusive, and supportive learning and working environments	Institutions implement effective measures to prevent sexual harassment, gender-based violence, discrimination, and unconscious bias while promoting student and staff well-being.
7. Strengthen financial support and incentives for gender equity	Expanded scholarships, fellowships, research grants, childcare support, and institutional incentive schemes that reduce financial and social barriers affecting women in STEM.
8. Build institutional capacity for gender mainstreaming	Academic and administrative staff possess the knowledge and skills to integrate gender considerations into teaching, research, curriculum development, project implementation, and institutional management.
9. Enhance gender-responsive data systems, monitoring, and evaluation	Comprehensive collection and use of sex-disaggregated data, regular gender audits, performance scorecards, and evidence-based reporting to inform policy and decision-making.
10. Strengthen partnerships and advocacy for gender equality	Strong collaboration among government agencies, higher education institutions, industry, civil society, development partners, and international organizations to advance gender equality in STEM.
11. Promote inclusive curriculum and gender-sensitive pedagogy	STEM curricula, teaching methods, and learning materials reflect gender-responsive approaches that encourage participation, reduce stereotypes, and improve learning outcomes.
12. Increase public awareness and societal support for women in STEM	Greater public recognition of women's contributions to STEM, reduced cultural barriers, and increased community support for girls' education, scientific careers, and innovation.

Strategic Activities

The following activities and programmes are designed to operationalize the Gender Strategy and achieve its strategic goals. The KPIs provide measurable indicators for monitoring progress and ensuring accountability across national, state, and institutional levels.

Table 6.13: Activities, Programmes and Key Performance Indicators (KPIs) for the Gender Strategy in Nigeria's STEM Transformation Strategy for Higher Education

Strategic Goal	Key Activities	Programmes	Key Performance Indicators (KPIs)
1. Expand equitable access and participation in STEM education	Provide targeted scholarships; strengthen outreach to secondary schools; organize STEM career campaigns; improve admission policies for equity (quota and/or affirmative action	National Women in STEM Scholarship Programme; Girls in STEM Outreach Initiative; STEM Bridge Programme	Number of scholarships awarded annually to female STEM students. Percentage increase in female STEM enrolment. Female retention and graduation rates. Number of outreach programmes conducted annually
2. Strengthen recruitment, retention and career progression of female STEM academics and researchers	Develop equitable recruitment guidelines; establish career development programmes; provide re-entry support after career breaks	Women in STEM Faculty Development Programme; Early Career Women Researchers Initiative	Percentage of female academic staff in STEM Percentage of women promoted annually. Number of female postdoctoral fellows supported. Staff retention rate of female academics
3. Institutionalize gender-responsive governance and policies	Develop institutional gender policies; establish Gender Equality Offices; integrate gender into strategic planning and budgeting	Gender Mainstreaming Programme; Institutional Gender Policy Development Initiative	Percentage of institutions with approved gender policies Number of functional Gender Equality Offices. Percentage of institutional budgets that include gender-responsive allocations Number of annual gender audits completed
4. Promote gender-inclusive research, innovation and entrepreneurship	Create competitive research grants; establish innovation hubs; support commercialization and startups led by women	Women Innovators Fund; Female Research Excellence Programme; Women in Innovation Hubs	Number of research grants awarded to women Number of women-led startups created Number of patents filed by women researchers .Number of innovation projects commercialized
5. Develop leadership and mentorship opportunities	Establish mentorship networks; provide executive leadership training; organize networking events	National Women in STEM Leadership Academy; National Mentorship Network	Number of mentorship pairs established. Number of women completing leadership programmes Percentage increase in women occupying leadership positions Participant satisfaction rate
6. Create safe, inclusive and supportive learning	Develop anti-harassment policies; establish reporting mechanisms; conduct awareness campaigns;	Safe Campus Initiative; Gender-Based Violence	Percentage of institutions implementing anti-harassment policies. Number of awareness

and working environments	improve counselling services	Prevention Programme	campaigns conducted. Number of trained counsellors Reduction in reported unresolved harassment cases
7. Strengthen financial support and incentives for gender equity	Introduce fellowships, childcare support, travel grants and research incentives for Women in STEM	Women in STEM Fellowship Scheme; Childcare Support Programme; Conference Mobility Grant	Number of fellowships awarded. Number of childcare support beneficiaries. Amount of research funding accessed by women Number of travel grants awarded
8. Build institutional capacity for gender mainstreaming	Train university leadership, lecturers and administrators; develop gender toolkits; integrate gender into curriculum review	Gender Capacity Development Programme; Gender-Responsive Curriculum Initiative	Number of staff trained annually Percentage of STEM programmes integrating gender perspectives Number of curriculum reviews completed Institutional gender capacity assessment scores
9. Enhance gender-responsive data systems, monitoring and evaluation	Establish gender databases; collect sex-disaggregated data; conduct institutional gender audits; publish annual reports	National Gender Observatory for Higher Education; Gender Data Management Programme	Percentage of institutions reporting sex-disaggregated data. Number of annual gender reports published. Number of institutions completing gender audits Data quality and reporting compliance rate
10. Strengthen partnerships and advocacy	Build partnerships with government, industry and development partners; organize annual gender forums; mobilize funding	National Gender Partnership Platform; Women in STEM Advocacy Campaign	Number of active partnerships established. Amount of external funding mobilized. Number of advocacy events organized. Number of collaborative projects implemented
11. Promote inclusive curriculum and gender-sensitive pedagogy	Review curricula; develop inclusive teaching materials; train lecturers in gender-responsive pedagogy	Gender-Responsive STEM Curriculum Reform Programme	Percentage of STEM curricula reviewed. Number of lecturers trained. Student satisfaction with inclusive learning environment. Number of gender-inclusive learning resources developed
12. Increase public awareness and societal support for women in STEM	Conduct media campaigns; celebrate women scientists; organize STEM competitions and community engagement activities	National Women in STEM Awareness Campaign; STEM Ambassadors Programme	Number of national awareness campaigns conducted. Media reach and engagement statistics. Number of STEM ambassadors appointed •Increase in public awareness measured through surveys
13. Improve women's participation in digital technology and innovation ecosystems	Train Women in STEM in digital technology		

Responsibilities

Table 6.14: Responsibility Matrix for the Gender Strategy in Nigeria's STEM Transformation Strategy for Higher Education

Strategic Activity	Lead Institution(s)	Supporting Institutions	Implementation Level (National, State, Institutional)
Develop and implement a National Gender Strategy for Higher Education and STEM	Federal Ministry of Education	Federal Ministry of Women Affairs; National Universities Commission; National Board for Technical Education; National Commission for Colleges of Education	National
Mainstream gender into institutional policies, strategic plans, and governance	National Universities Commission	Universities, Polytechnics, Colleges of Education, Governing Councils, State Ministries of Education	National, Institutional
Establish Gender Equality and Inclusion Offices in tertiary institutions	Universities, Polytechnics and Colleges of Education	National Universities Commission; National Board for Technical Education; National Commission for Colleges of Education	Institutional
Expand scholarships and financial support for women in STEM	Tertiary Education Trust Fund	Federal Ministry of Education; State Governments; Development Partners; Private Sector; Philanthropic Foundations	National, State, Institutional
Increase enrolment and retention of girls and women in STEM programmes	Universities, Polytechnics and Colleges of Education	State Ministries of Education; Secondary Schools; Professional Associations; Community Organizations	State, Institutional
Strengthen recruitment, promotion, and retention of female academic staff	Governing Councils and Institutional Management	National Universities Commission; Academic Staff Unions; Federal Ministry of Education	Institutional
Establish national mentorship and leadership programmes for women in STEM	Federal Ministry of Education	Federal Ministry of Women Affairs; Universities; Professional Associations; Industry; Alumni Networks	National, Institutional
Build institutional capacity on gender mainstreaming	National Universities Commission	National Board for Technical Education; National Commission for Colleges of Education; Universities; Development Partners	National, Institutional
Promote women-led research, innovation, and entrepreneurship	Tertiary Education Trust Fund	National Information Technology Development Agency; Universities; Industry; Innovation Hubs; Development Partners	National, Institutional
Integrate gender considerations into research funding and grant allocation	Tertiary Education Trust Fund	National Universities Commission; Research Councils; Development Partners	National
Develop gender-responsive STEM curricula and teaching practices	National Universities Commission	National Board for Technical Education; National Commission for Colleges of Education; Universities; Professional Bodies	National, Institutional

Prevent sexual harassment, gender-based violence, and discrimination	Institutional Governing Councils	Federal Ministry of Education; Federal Ministry of Women Affairs; Student Affairs Divisions; Security Agencies	Institutional
Strengthen counselling, psychosocial support, and reporting systems	Universities, Polytechnics and Colleges of Education	Federal Ministry of Health; NGOs; Student Associations	Institutional
Establish a National Women in STEM Leadership and Mentorship Network	Federal Ministry of Education	Federal Ministry of Women Affairs; Professional Associations; Industry; Development Partners	National
Promote work-life balance through family-friendly institutional policies	Institutional Management	Governing Councils; Staff Unions; Federal Ministry of Education	Institutional
Strengthen gender-responsive budgeting across higher education institutions	Federal Ministry of Education	Federal Ministry of Finance; Tertiary Education Trust Fund; National Universities Commission	National, Institutional
Establish national gender-disaggregated education and research databases	National Universities Commission	National Bureau of Statistics; Federal Ministry of Education; Institutions	National
Conduct institutional gender audits and annual performance reviews	National Universities Commission	Universities; National Board for Technical Education; National Commission for Colleges of Education; External Auditors	National, Institutional
Launch national advocacy and public awareness campaigns on women in STEM	Federal Ministry of Women Affairs	Federal Ministry of Education; Media Organizations; Professional Associations; Civil Society Organizations	National, State
Strengthen partnerships with industry, international organizations, and development partners	Federal Ministry of Education	Tertiary Education Trust Fund; Universities; Industry Associations; Development Partners	National
Monitor, evaluate, and publish annual Gender Strategy implementation reports	Federal Ministry of Education	National Universities Commission; National Board for Technical Education; National Commission for Colleges of Education; National Bureau of Statistics	National, State, Institutional

Key Performance Indicators

A robust monitoring and evaluation framework is essential for tracking progress toward achieving gender equality in Nigeria's higher education and STEM ecosystem. The Key Performance Indicators (KPIs) in Table 6.15 provide measurable benchmarks to assess implementation at national, state, and institutional levels. Baseline values reflect the current situation at the commencement of the strategy (to be confirmed through a national gender audit), while short-, medium-, and long-term targets provide realistic milestones over a 10-year implementation period. These indicators are aligned with the Federal Ministry of Women Affairs National Gender Policy (2021), the United Nations Sustainable Development Goals (particularly SDGs 4 and 5), the African Union Agenda 2063, and UNESCO recommendations on gender equality in higher education and STEM.

Table 6.15: Key Performance Indicators (KPIs) for the Gender Strategy in Nigeria's STEM Transformation Strategy for Higher Education

Strategic Area	Key Performance Indicator (KPI)	Baseline (Year 0)	Short-Term Target (Years 1–3)	Medium-Term Target (Years 4–6)	Long-Term Target (Years 7–10)
STEM Access and Participation	Female enrolment in STEM programmes	~35%*	40%	45%	≥50%
	Female completion rate in STEM programmes	~70%	80%	90%	≥95%
	Number of institutions implementing girls' STEM outreach programmes	<30 institutions	100 institutions	200 institutions	All public tertiary institutions
Academic Workforce	Female academic staff in STEM disciplines	~24%*	30%	35%	45%
	Women in professorial positions in STEM	~15%*	20%	30%	40%
	Women occupying senior academic leadership positions (VCs, Rectors, Provosts, Deans, Directors)	~18%*	25%	35%	50%
Leadership and Governance	Institutions with approved gender policies	<20%	60%	90%	100%
	Institutions with functional Gender Equality Offices	<15%	50%	80%	100%
	Institutions implementing gender-responsive budgeting	<10%	40%	75%	100%
Research and Innovation	Share of competitive research grants awarded to women	~20%	30%	40%	50%
	Women-led research projects funded annually	Baseline to be established	+30%	+60%	+100%
	Women-led patents registered	Baseline to be established	+20%	+50%	+100%
	Women-led technology startups incubated	Baseline to be established	100 startups	300 startups	600 startups
Scholarships and Capacity Development	Female STEM scholarships awarded annually	Baseline to be established	5,000	12,000	25,000
	Female postgraduate fellowships awarded	Baseline to be established	500	1,500	3,000

	Female researchers receiving international mobility grants	Baseline to be established	300	800	1,500
Leadership and Mentorship	Women participating in structured mentorship programmes	<5,000	20,000	50,000	100,000
	Women completing STEM leadership programmes	Baseline to be established	2,000	5,000	10,000
Institutional Capacity	Staff trained in gender mainstreaming	<10%	40%	70%	100%
	Institutions conducting annual gender audits	<10%	50%	80%	100%
	STEM curricula reviewed using gender-responsive standards	<5%	40%	80%	100%
Safe Learning Environment	Institutions with operational anti-sexual harassment policies	~35%	70%	90%	100%
	Institutions with confidential reporting and response mechanisms	<25%	70%	90%	100%
	Reduction in unresolved gender-based violence complaints	Baseline to be established	30% reduction	60% reduction	90% reduction
Data and Monitoring	Institutions reporting sex-disaggregated STEM data annually	<20%	70%	90%	100%
	National Gender in Higher Education Report published	None	Annual publication	Annual publication	Annual publication
	National Gender Observatory established	None	Established	Fully operational	Internationally recognized
Partnerships and Advocacy	Active partnerships supporting women in STEM	<20	80	150	250
	Annual investment mobilized for gender initiatives	Baseline to be established	₦20 billion	₦60 billion	₦120 billion
	National awareness campaigns implemented annually	Limited	12 campaigns/year	24 campaigns/year	Continuous nationwide campaigns

Timelines

The implementation of the Gender Strategy should be undertaken in four sequential phases over a **10-year period** to ensure systematic institutional reforms, sustainable capacity development, and measurable improvements in gender equality across Nigeria's higher education and STEM ecosystem. The phased approach enables gradual scaling of interventions, effective resource mobilization, continuous monitoring, and evidence-based policy adjustments. It also aligns with the implementation cycles of the Federal Ministry of Education, National Universities Commission, National Board for Technical Education, National Commission for Colleges of Education, and Tertiary Education Trust Fund.

Table 6.16: Implementation Timeline for the Gender Strategy in Nigeria's STEM Transformation Strategy for Higher Education

Phase	Timeline	Major Activities
Phase I: Policy Development and Institutional Readiness	**Years 1–2**	Develop and approve the National Gender Strategy for Higher Education and STEM. Conduct a national gender baseline survey and institutional gender audits. Establish Gender Equality Units/Offices in tertiary institutions. Develop institutional gender policies and implementation guidelines. Create national coordination and monitoring mechanisms. Build awareness through national advocacy campaigns. Train institutional gender focal persons and senior management. Develop a national gender-disaggregated data management system.
Phase II: Capacity Building and Programme Roll-out	**Years 3–5**	Launch scholarships, fellowships, and grants for women in STEM. Establish mentorship and leadership development programmes. Implement gender-responsive budgeting across institutions. Review STEM curricula using gender-responsive standards. Introduce anti-sexual harassment policies and reporting mechanisms.Expand outreach programmes for girls in STEM. Strengthen partnerships with industry and development partners.
Phase III: Expansion, Innovation and Institutionalization	**Years 6–8**	Scale up women-led research and innovation programmes. Expand technology incubation and entrepreneurship initiatives. Increase female representation in institutional leadership. Strengthen research grants and commercialization support. Conduct mid-term evaluation and policy review. Scale up institutional gender audits.Strengthen national and international partnerships.
Phase IV: Sustainability, Evaluation and Global Competitiveness	**Years 9–10**	Conduct final evaluation of the Gender Strategy. Institutionalize gender-responsive governance across all tertiary institutions. Strengthen sustainability financing mechanisms. Benchmark institutional performance internationally. Publish national impact assessment reports. Recognize outstanding institutional performance through awards and incentives. Develop the next-generation Gender Strategy based on lessons learned.

Expected Outputs

The implementation of the Gender Strategy is expected to produce measurable outputs at each phase of the 10-year implementation period Table 6.17. These outputs build progressively from policy development and institutional readiness to full institutionalization and sustainability of gender-responsive practices across Nigeria's higher education system.

Table 6.17: Expected Outputs by Implementation Phase for the Gender Strategy in Nigeria's STEM Transformation Strategy for Higher Education

Implementation Phase	Timeline	Expected Outputs
Phase I: Policy Development and Institutional Readiness	**Years 1–2**	National Gender Strategy for Higher Education and STEM developed and approved. National implementation framework and governance structure established. National gender baseline survey and institutional gender audits completed. Gender Equality Units/Offices established in at least 70% of public tertiary institutions. Institutional gender policies and guidelines developed. National gender-responsive monitoring and evaluation framework established. National sex-disaggregated higher education database developed. Gender focal people appointed and trained in all federal institutions. Awareness campaigns on gender equality launched nationwide. Initial funding mechanisms for gender programmes established.
Phase II: Capacity Building and Programme Implementation	**Years 3–5**	National Women in STEM Scholarship and Fellowship Programme operational. National mentorship and leadership development programmes established. Gender-responsive budgeting implemented in most public tertiary institutions. STEM curricula reviewed to incorporate gender-responsive teaching approaches. Anti-sexual harassment and gender-based violence policies fully operational. Institutional counselling and reporting mechanisms strengthened. Staff trained on gender mainstreaming and inclusive leadership. Increased enrolment, retention, and graduation of women in STEM programmes. Strong partnerships established with industry, professional bodies, and development partners. Annual institutional gender reports published.
Phase III: Expansion, Innovation and Institutionalization	**Years 6–8**	Women-led research grant programmes expanded nationally. Women-led innovation hubs and technology incubation programmes operational. Increased number of women researchers, inventors, entrepreneurs, and patent holders. Greater representation of women in academic leadership and institutional governance. Institutional gender audits conducted annually across all public tertiary institutions. National Women in STEM Leadership Network fully operational. Mid-term evaluation completed and strategy refined. Increased commercialization of women-led research and innovation. Strengthened international collaborations and resource mobilization. National gender performance scorecard published annually.
Phase IV: Sustainability, Evaluation and Global Competitiveness	**Years 9–10**	Gender-responsive governance institutionalized across all higher education institutions. Gender equality integrated into institutional planning, budgeting, accreditation, and quality assurance systems. Sustainable financing mechanisms for gender programmes established. National impact assessment completed and published. Significant improvement in female representation in STEM education, research, leadership, and innovation achieved. Nigeria recognized as a regional leader in gender-inclusive STEM education and research. Institutional best practices documented and scaled nationally. National Gender Observatory fully operational. International benchmarking completed against leading higher education systems. Next-generation Gender Strategy (post-implementation roadmap) developed.

CHAPTER SEVEN

IMPLEMENTATION AND INSTITUTIONAL FRAMEWORK

The successful implementation of Nigeria's ICT-enabled STEM Transformation Strategy for Higer Education depends on a robust implementation and institutional framework that provides clear governance structures, defined roles and responsibilities, effective coordination mechanisms, sustainable financing, and a strong monitoring and evaluation system. Given the multi-sectoral nature of STEM education and its links to research, innovation, industry, digital transformation, and national development, this strategy requires close collaboration among the Federal Government, state governments, regulatory agencies, tertiary institutions, industry, development partners, and the private sector. Such a coordinated framework is essential to ensure policy coherence, efficient resource utilization, accountability, and nationwide consistency in implementation.

The implementation framework therefore, is designed to translate the strategic overall vision into measurable actions through a phased and results-oriented approach. It establishes institutional arrangements for planning, coordination, execution, monitoring, and continuous improvement at the national, state, and institutional levels. Central to the framework is the establishment of a National Programme Management Unit (PMU) and a multi-stakeholder governance structure that shall coordinate implementation across key ministries, departments, agencies, and higher education institutions. Regulatory bodies including the National Universities Commission (NUC), National Board for Technical Education (NBTE), and National Commission for Colleges of Education (NCCE) will provide quality assurance, standards, and compliance, while agencies such as the Tertiary Education Trust Fund (TETFund), the National Information Technology Development Agency (NITDA), and the Nigerian Communications Commission (NCC) will support infrastructure development, digital transformation, research, and capacity building.

At the institutional level, universities, polytechnics, and colleges of education shall serve as the primary implementation centres, integrating the strategy into their strategic plans, academic programmes, research agendas, and administrative systems. Industry partners, professional bodies, research institutes, innovation hubs, and development partners will contribute through collaborative research, curriculum development, technology transfer, internships, entrepreneurship support, and resource mobilization. The framework also emphasizes inclusive stakeholder engagement to ensure that women, persons with disabilities, underserved regions, and other marginalized groups benefit equitably from the transformation process.

To ensure transparency, accountability, and evidence-based decision-making, the framework incorporates a comprehensive monitoring, evaluation, accountability, and learning (MEAL) system supported by digital performance dashboards, key performance indicators (KPIs), periodic reviews, independent evaluations, and annual progress reporting. This results-based implementation approach shall enable continuous tracking of progress, timely identification of implementation challenges, adaptive management, and informed policy adjustments.

Overall, the implementation and institutional framework provide the governance architecture necessary to deliver a coordinated, sustainable, and nationally scalable ICT-enabled STEM transformation. By aligning institutional responsibilities, financing mechanisms, implementation timelines, and performance monitoring with Nigeria's national development

priorities and international best practices, the framework will support the development of a resilient, innovative, and globally competitive tertiary education system capable of producing the skilled workforce, research outputs, and technological innovations required to drive sustainable socio-economic development.

7.1 Phased Implementation Plan

Nigeria's ICT-driven STEM Transformation for higher education shall be implemented in a phased implementation framework. Table 7.1a presents the overall implementation Timeline while Tables 7.1b to 7.1e presents the implementation matrix for each phase.

Table 7.1a: STEM Transformation for higher education implementation framework

Phase	Duration	Strategic Focus
Phase 1	2026 - 2028	Foundation and Policy Readiness
Phase 2	2029 - 2031	Infrastructure Expansion and Digital Integration
Phase 3	2031 - 2033	Research, Innovation and Smart STEM Ecosystems
Phase 4	2033 – 2036	Global Competitiveness and Sustainability

Table 7.1b: Phase 1 Foundation and policy readiness implementation matrix

Strategic Objective	Key Activities	Lead Institutions	Expected Outputs	Key Performance Indicators (KPIs)
Establish the governance, policy, institutional, and digital foundations required for nationwide ICT-driven STEM transformation.	Develop the National ICT-STEM Transformation Policy and Implementation Framework. Establish the National STEM Transformation Steering Committee and Programme Management Unit (PMU). Conduct nationwide digital readiness and STEM infrastructure assessments. Develop standards for smart campuses, digital learning, AI integration, cybersecurity, and interoperability.	Federal Ministry of Education (FME), NUC, NBTE, NCCE, TETFund, NITDA, NCC, Federal Ministry of Communications, Innovation and Digital Economy (FMCIDE)	National policy approved. Governance structures operational. National baseline assessment completed. Smart campus pilots established. National implementation guidelines developed.	National policy approved. PMU established. 100% federal tertiary institutions assessed. 12 Smart Campus pilots operational. 20,000 lecturers trained in digital pedagogy.

	Launch pilot Smart Campus initiatives across the six geopolitical zones. Build institutional capacity through digital pedagogy and ICT skills training. Develop a national Monitoring, Evaluation, Accountability and Learning (MEAL) framework.			

Table 7.1c: Phase 11 Infrastructure Expansion and Digital Integration implementation matrix

Strategic Objective	Key Activities	Lead Institutions	Expected Outputs	Key Performance Indicators (KPIs)
Expand ICT infrastructure and mainstream digital technologies into teaching, learning, research, and institutional management.	Expand broadband connectivity to all tertiary institutions. Upgrade STEM laboratories into smart laboratories. Deploy Learning Management Systems (LMS), ERP, digital libraries, and student information systems. Establish AI, robotics, cybersecurity, IoT, and cloud computing laboratories. Introduce virtual laboratories and blended learning programmes. Deploy renewable energy solutions to support digital campuses. Strengthen institutional cybersecurity systems.	FME, TETFund, NUC, NBTE, NCCE, NITDA, NCC, Rural Electrification Agency (REA), State Governments, Tertiary Institutions	Nationwide broadband connectivity. Smart laboratories operational. Digital governance systems deployed. Hybrid learning institutionalized. Improved digital teaching and research infrastructure.	90% of institutions connected to broadband. 150 Smart STEM laboratories established. 80% of institutions using ERP systems. Two million students enrolled in blended STEM programmes. 50 smart campuses powered by renewable energy.

Table 7.1d: Phase 3 Research, Innovation and Smart STEM Ecosystems implementation Matrix

Strategic Objective	Key Activities	Lead Institutions	Expected Outputs	Key Performance Indicators (KPIs)
Strengthen research excellence, innovation ecosystems, entrepreneurship, and industry collaboration through advanced digital technologies.	Establish National STEM Centres of Excellence. Create innovation hubs, technology parks, FabLabs, and startup incubators. Develop national research repositories and open science platforms. Expand AI-assisted learning and institutional analytics. Strengthen university-industry partnerships and commercialization programmes. Support interdisciplinary STEM research and innovation clusters. Promote technology transfer and intellectual property development.	FME, TETFund, NUC, National Office for Technology Acquisition and Promotion (NOTAP), Raw Materials Research and Development Council (RMRDC), National Agency for Science and Engineering Infrastructure (NASENI), Industry Partners, Research Institutes	Functional innovation ecosystems. Increased commercialization of research outputs. Strong university-industry collaboration. National research data infrastructure established. Expanded AI-enabled education systems.	36 Centres of Excellence established. 72 innovation hubs operational. 1,000 STEM startups are incubated annually. 500 industry-funded research projects. 300 patents filed annually.

Table 7.1e: Phase 4 Global Competitiveness and Sustainability Implementation Matrix

Strategic Objective	Key Activities	Lead Institutions	Expected Outputs	Key Performance Indicators (KPIs)
Position Nigeria as Africa's leading ICT-driven STEM education, research, and innovation hub while ensuring sustainability of the transformation.	Expand international partnerships and joint research programmes. Promote international accreditation and global rankings. Scale up commercialization of research and innovation exports. Institutionalize continuous ICT upgrades and AI governance. Implement annual digital maturity assessments. Strengthen sustainability financing through PPPs, endowments, and commercialization revenues. Conduct comprehensive impact evaluations and policy reviews.	FME, Ministry of Foreign Affairs, NUC, NBTE, NCCE, TETFund, Nigerian Investment Promotion Commission (NIPC), Industry, Development Partners	Internationally competitive tertiary institutions. Sustainable digital transformation ecosystem. Increased research commercialization. Strong global STEM partnerships. Enhanced graduate employability and innovation capacity.	20 Nigerian institutions ranked among Africa's leading STEM institutions. 200 international research partnerships. 85% graduate digital employability rate. Significant annual increase in research commercialization revenue. National Digital STEM Maturity Index published annually.

If effectively implemented, the strategy will not only strengthen Nigeria's tertiary education system but also accelerate the country's transition toward a knowledge-driven, innovation-led, and digitally competitive economy aligned with global technological trends and sustainable development priorities

7.2 Roles and Responsibilities

The successful implementation of the Nigerian ICT-Enabled STEM Transformation Strategy for Higher Education requires a coordinated, multi-stakeholder governance framework that clearly defines the roles and responsibilities of all participating institutions. Table 7.2 presents a summary of the expected roles and responsibilities of all the major stakeholders, Given the complexity of transforming higher education nationwide, implementation is shared in

responsibility model involving the Federal Government, State Governments, regulatory agencies, higher institutions, industry partners, development partners, professional bodies and societies, diaspora partners, civil society and foundations, and students. This collaborative approach ensures policy coherence, efficient resource mobilization, accountability, and sustainable delivery of the Strategy's objectives.

At the national level, the Federal Government provides strategic leadership through policy formulation, funding, coordination, monitoring, and international partnerships. Regulatory agencies establish quality standards, accreditation requirements, digital governance frameworks, and performance monitoring systems to ensure consistency across universities, polytechnics, colleges of education, and other tertiary institutions. State Governments complement these efforts by supporting state-owned institutions through infrastructure investment, policy alignment, and regional implementation initiatives.

Higher education institutions serve as the primary implementation units, responsible for translating national policies into institutional action through curriculum modernization, digital transformation, research development, faculty capacity building, innovation ecosystems, and industry engagement. Academic staff, administrators, students, and governing councils each play distinct roles in ensuring institutional ownership and sustainability.

The private sector, research organizations, professional associations, and development partners provide essential support through funding, technology transfer, internships, research collaboration, entrepreneurship development, equipment donation, and capacity-building programmes. Their active participation strengthens the relevance of STEM education to labour market needs while promoting innovation and commercialization of research outputs.

A robust implementation framework shall establish clear mechanisms for coordination, performance management, financial accountability, and continuous monitoring and evaluation. Effective communication among stakeholders, evidence-based decision-making, periodic performance reviews, and transparent reporting shall be essential for achieving the Strategy's long-term objectives. International experience demonstrates that successful STEM transformation depends not only on adequate investment but also on strong institutional governance, collaborative leadership, and clearly assigned responsibilities across all levels of implementation.

Table 7.2: Roles and Responsibilities of each Stakeholder group in the Implementation of Nigeria’s ICT-enabled STEM Transformation in Higer Education

Stakeholder	Primary Roles and Responsibilities
1. Federal Government Institutions *(Federal Ministry of Education, Federal Ministry of Innovation, Science and Technology, Federal Ministry of Communications, Innovation and Digital Economy, Federal Ministry of Finance, Budget and National Planning, TETFund, National Information Technology Development Agency (NITDA), Galaxy Backbone, etc.)*	Provide overall policy leadership and national coordination. Develop and approve national STEM policies, implementation guidelines, and regulatory frameworks. Mobilize and allocate funding for implementation. Establish national STEM governance structures and Programme Management Office (PMO) Coordinate inter-ministerial collaboration. Invest in national digital and research infrastructure. Promote public-private partnerships. Monitor national implementation progress and report to the Federal Executive Council.
2. Regulatory Agencies *(National Universities Commission (NUC), National Board for Technical*	Review and approve modernized STEM curricula. Develop national quality assurance standards.

Education (NBTE), National Commission for Colleges of Education (NCCE), National Board for Technical Education, National Universities Commission, Nigerian Research and Education Network (NgREN), etc.)	Establish accreditation requirements for emerging STEM programmes. Monitor institutional compliance with national standards. Develop digital learning and assessment standards. Collect and publish STEM performance data.Support implementation monitoring and evaluation.
3. Universities, Polytechnics and Colleges of Education	Develop institutional STEM transformation plans aligned with national strategy. Modernize curricula and teaching methods. Recruit, train, and retain qualified STEM faculty. Upgrade laboratories, digital infrastructure, and innovation hubs. Establish industry partnerships and entrepreneurship programmes. Implement research commercialization initiatives. Monitor institutional KPIs and report progress. Ensure inclusive participation of women and underserved groups.
4. Research Institutes	Conduct priority national STEM research. Collaborate with universities on joint research programmes. Share advanced research facilities and laboratories. Mentor postgraduate students and early-career researchers. Support technology development, patents, and commercialization. Generate evidence to inform national STEM policy. Participate in national Centres of Excellence and research clusters.
5. Private Sector Partners *(Industry, ICT companies, manufacturing firms, financial institutions, startups, chambers of commerce, professional associations)*	Provide industry-relevant skills requirements. Co-design STEM curricula with institutions. Offer internships, apprenticeships, and industrial attachments. Invest in research, innovation, and commercialization. Support innovation hubs and startup incubation. Donate equipment and technology platforms. Provide scholarships, research grants, and venture capital. Facilitate graduate employment opportunities.
6. Development Partners *(World Bank, African Development Bank, UNICEF, UNESCO, UNDP, British Council, GIZ, USAID, JICA, Commonwealth Secretariat, etc.)*	Provide technical assistance and advisory support. Finance strategic STEM programmes and infrastructure. Support policy development and institutional reforms. Build institutional capacity through training programmes. Facilitate international knowledge exchange and benchmarking. Support monitoring, evaluation, and impact assessment. Promote inclusive STEM education and gender equity initiatives.
7. State Governments	Align state education policies with the national STEM strategy. Provide counterpart funding for state-owned tertiary institutions. Upgrade infrastructure in state institutions. Support recruitment of qualified STEM academics. Promote state-level innovation ecosystems and research collaborations. Facilitate partnerships with local industries. Monitor implementation in state-owned institutions and report progress.
8. Diaspora and International Academic Partners	Facilitate international research collaboration and joint grants. Support faculty exchange programmes and visiting professorships. Mentor Nigerian researchers and postgraduate students. Provide specialized training in emerging STEM fields. Support curriculum modernization using global best practices. Promote international accreditation and quality assurance. Facilitate technology transfer, innovation, and commercialization. Assist in

	attracting global research funding and international partnerships.
9. Professional Bodies and Academic Societies *(e.g., Nigerian Society of Engineers (NSE), Chemical Society of Nigeria, Computer Professionals Registration Council of Nigeria, Nigeria Computer Society, Mathematical Association of Nigeria, Science Teachers Association of Nigeria, Institute of Electrical and Electronics Engineers, organisation for women in science for the developing world, International Union of Pure and Applied Chemistry, Association of Commonwealth Universities, etc.)*	Provide professional standards and competency frameworks for STEM disciplines. Advise on curriculum development and periodic curriculum review to align with international standards and industry needs. Support accreditation and quality assurance of STEM programmes in collaboration with regulatory agencies. Deliver continuous professional development (CPD), certification, and lifelong learning opportunities for academics, researchers, and technical staff. Organize conferences, workshops, competitions, and knowledge-sharing platforms to promote research excellence and innovation. Facilitate collaboration among academia, industry, government, and international partners. Promote ethical conduct, professional practice, and research integrity. Support mentoring programmes for students, early-career academics, and women in STEM. Advocate evidence-based STEM policies and contribute expert input to national policy formulation. Recognize excellence through awards, fellowships, and professional recognition schemes.Support international networking, research collaboration, and mobility of Nigerian STEM scholars.• Promote entrepreneurship, innovation, technology commercialization, and industry certification relevant to emerging technologies.
10. Civil Society Organizations (CSOs), NGOs, Community-Based Organizations (CBOs), and Philanthropic Foundations *(e.g., STEM-focused NGOs, education advocacy organizations, community development organizations, youth organizations, women-in-STEM organizations, corporate foundations, international philanthropic foundations, faith-based organizations, and charitable trusts*	Advocate for equitable and inclusive access to quality STEM education, particularly for women, persons with disabilities, disadvantaged groups, and underserved communities. Support community outreach, STEM awareness campaigns, science fairs, coding clubs, robotics competitions, and innovation programmes. Provide scholarships, bursaries, fellowships, and financial assistance to students from disadvantaged backgrounds. Mobilize philanthropic funding and resources for STEM education, research, laboratories, digital infrastructure, and innovation hubs. Implement programmes that encourage girls' participation and retention in STEM disciplines. Support teacher development, digital literacy, and community-based STEM education initiatives. Facilitate partnerships between educational institutions, communities, industry, and government. Promote public awareness of the importance of STEM education through advocacy and communication campaigns. Support monitoring, social accountability, and citizen engagement in the implementation of the STEM Transformation Strategy. Sponsor innovation challenges, entrepreneurship programmes, hackathons, and startup incubation initiatives. Provide mentoring, career guidance, and leadership development opportunities for students and young researchers. Contribute evidence and policy recommendations to strengthen STEM education and workforce development.
11. Students ***(Undergraduate, postgraduate, technical and vocational students, student unions,***	Actively participate in modernized STEM teaching, learning, and research programmes. Develop digital,

STEM clubs, innovation teams, entrepreneurship clubs, and student associations)	entrepreneurial, innovation, and employability skills through academic and co-curricular activities. Participate in internships, industrial attachments, apprenticeships, and work-integrated learning programmes. Engage in research, innovation, hackathons, competitions, and startup incubation programmes. Provide feedback on curriculum quality, teaching effectiveness, digital learning platforms, and student support services. Promote responsible and ethical use of digital technologies, artificial intelligence, and research practices. Participate in student leadership, governance committees, and institutional quality assurance processes. Serve as peer mentors and ambassadors for STEM awareness, innovation, and entrepreneurship within their institutions and communities. Collaborate with faculty, industry, and research institutes on applied research and innovation projects. Champion inclusivity by supporting initiatives that encourage the participation of women, persons with disabilities, and other underrepresented groups in STEM. Build lifelong learning competencies through continuous professional development, micro-credentials, certifications, and digital skills training. Contribute to institutional and national monitoring and evaluation through surveys, tracer studies, graduate outcome assessments, and feedback mechanisms

Civil society organizations and philanthropic foundations contribute significantly to the sustainability and inclusiveness of the Nigerian ICT-enabled STEM Transformation Strategy. They complement government efforts by mobilizing additional financial and technical resources, expanding access to STEM opportunities for marginalized populations, and fostering public participation in education reform. Their close engagement with communities enables them to identify local needs, pilot innovative interventions, and support grassroots implementation of national policies.

In addition, philanthropic foundations can catalyze innovation by funding high-impact projects, supporting research infrastructure, establishing endowed chairs and scholarship programmes, and investing in entrepreneurship ecosystems. Civil society organizations also enhance transparency and accountability by monitoring programme implementation, promoting stakeholder engagement, and ensuring that the benefits of STEM transformation reach all regions and demographic groups.

Students are at the centre of the Nigerian ICT-enabled STEM Transformation Strategy and are its most important stakeholders. Their active participation ensures that STEM reforms are relevant, learner-centred, and responsive to emerging technologies and labour market demands. Beyond being recipients of education, students are innovators, researchers, entrepreneurs, and future leaders who will drive Nigeria's knowledge economy.

Engaging students throughout planning, implementation, monitoring, and evaluation strengthens institutional accountability, improves learning outcomes, and fosters a culture of innovation, collaboration, and lifelong learning. Student-led innovation hubs, entrepreneurship

clubs, research teams, and STEM societies also contribute significantly to technology development, commercialization, and community engagement.

7.3 Inter-Ministerial Coordination Mechanism

An **Inter-Ministerial Coordination Mechanism (IMCM)** shall be established as the highest government coordination body responsible for ensuring policy coherence, cross-sectoral collaboration, and whole-of-government implementation of the Nigerian ICT-enabled STEM Transformation Strategy for Higher Education. Since the strategy spans education, science, technology, digital economy, finance, labour, industry, and economic development, no single ministry can effectively implement it in isolation. The function, roles and responsibility of the IMCM is presented in Table 7.3.

Table 7.3: Roles and Responsibilities of the Inter-Ministerial Coordination Mechanism

Function	Roles and Responsibilities
Strategic Leadership	Provide high-level strategic oversight for implementation of the national STEM Transformation Strategy. Ensure alignment with national development priorities, including national education, digital economy, industrialization, innovation, and human capital development policies. Approve annual implementation priorities and strategic directions.
Policy Coordination	Harmonize policies, programmes, and regulations across ministries, departments, and agencies (MDAs). Resolve policy inconsistencies and eliminate duplication of initiatives. Coordinate legislative and regulatory reforms required for STEM transformation.
Resource Mobilization	Coordinate national budget planning for STEM transformation. Promote joint financing across ministries. Mobilize external funding from development partners and international financing institutions. Facilitate public-private partnerships and private sector investment.
Inter-Agency Coordination	Coordinate the activities of ministries, regulatory agencies, and implementing institutions. Clarify institutional mandates and responsibilities. Promote information sharing and collaborative programme implementation.
Implementation Oversight	Review implementation progress against national targets and Key Performance Indicators (KPIs). Address implementation bottlenecks and emerging risks. Provide strategic guidance to the National Programme Management Office (PMO).
Monitoring, Evaluation and Accountability	Approve national monitoring and evaluation frameworks. Review periodic implementation reports and performance dashboards. Hold implementing institutions accountable for agreed deliverables. Recommend corrective actions where performance gaps exist.
Digital and Research Infrastructure Coordination	Coordinate national investments in digital infrastructure, broadband connectivity, research laboratories, supercomputing facilities, data centres, and shared scientific equipment. Promote interoperability among national education and research platforms.
Industry and Innovation Coordination	Strengthening collaboration between government, academia, industry, and innovation ecosystems. Promote commercialization of research and technology transfer. Coordinate national initiatives on entrepreneurship, startup development, and workforce readiness.
Stakeholder Engagement	Facilitate engagement with state governments, tertiary institutions, research institutes, professional bodies, industry, civil society, students, and development partners. Promote transparency, communication, and stakeholder participation throughout implementation.
International Cooperation	Coordinate international partnerships, bilateral and multilateral cooperation, and global STEM initiatives. Promote technology transfer, international research

	collaboration, and academic mobility.Benchmark Nigeria's progress against international best practices.
Risk Management	Identify strategic implementation risks. Develop mitigation measures for financial, institutional, technological, and policy risks. Ensure continuity of implementation across political administrations.

Proposed Composition

The Inter-Ministerial Coordination Mechanism should be chaired by the **Federal Ministry of Education**, with a co-chair arrangement involving the **Federal Ministry of Innovation, Science and Technology** and the **Federal Ministry of Communications, Innovation and Digital Economy**.

Membership should include senior representatives from:

1. Federal Ministry of Education (Chair)
2. Federal Ministry of Innovation, Science and Technology
3. Federal Ministry of Communications, Innovation and Digital Economy
4. Federal Ministry of Finance
5. Federal Ministry of Budget and Economic Planning
6. Federal Ministry of Labour and Employment
7. Federal Ministry of Industry, Trade and Investment
8. Federal Ministry of Women Affairs
9. Federal Ministry of Youth Development
10. Federal Ministry of Environment
11. Federal Ministry of Health (for health-related STEM programmes)
12. Federal Ministry of Agriculture and Food Security (for agricultural STEM programmes)
13. Regulatory agencies (e.g., NUC, NBTE, NCCE, TETFund, NITDA)
14. Representatives of State Governments
15. Private Sector Advisory Group

Expected Outcomes

An effective Inter-Ministerial Coordination Mechanism shall:

1. Ensure coherent implementation across all government ministries and agencies.
2. Improve efficiency by reducing duplication and fragmentation of STEM initiatives.
3. Accelerate decision-making and resolution of cross-sectoral implementation challenges.
4. Strengthen accountability through regular performance reviews and coordinated reporting.
5. Mobilize sustainable financing from government, private sector, and development partners.
6. Foster stronger partnerships between academia, industry, government, and international collaborators.
7. Ensure that STEM transformation contributes directly to Nigeria's human capital development, digital economy, industrialization, innovation, and sustainable development goals.

This mechanism should serve as the **highest policy coordination body** for the strategy, while the **National STEM Programme Management Office (PMO)** functions as the **executive and operational arm**, responsible for day-to-day coordination, implementation support, monitoring, and reporting. Together, these two entities provide the governance structure needed for successful nationwide implementation.

7.4 Legislative and Regulatory Amendments Required

Implementing a comprehensive STEM ICT driven Transformation Strategy in Nigeria shall require substantial legislative, regulatory, and institutional reforms across education, research, innovation, digital infrastructure, industry, and public finance systems. Existing policies already recognize the need for stronger legal frameworks to drive Science, Technology and Innovation (STI) implementation and coordination (Federal Ministry of Education, 2018).

Legislative and regulatory reforms are therefore essential to remove policy bottlenecks, modernize quality assurance systems, facilitate interdisciplinary STEM programmes, promote digital credentials and online learning, strengthen research commercialization, and establish sustainable financing mechanisms for STEM education and research. The reforms shall clarify institutional responsibilities, enhance coordination among ministries and regulatory agencies, encourage public-private partnerships, and create incentives for investment in research infrastructure, innovation ecosystems, and human capital development. In addition, regulatory amendments shall support the adoption of artificial intelligence, big data, cloud computing, cybersecurity, open science, digital research infrastructure, and emerging technologies while ensuring compliance with ethical standards, data protection, intellectual property rights, and international best practices. The legislative framework shall equally promote inclusiveness by strengthening provisions that improve access to STEM education for women, persons with disabilities, underserved communities, and disadvantaged regions.

The proposed legislative and regulatory amendments (Table 7.4) and the new legislation and regulation (Table 7.5) shall be implemented through close collaboration among the Federal Ministry of Education, the National Assembly, sector regulators, professional bodies, tertiary education institutions, industry partners, and state governments. This collaborative approach shall ensure that the regulatory environment remains responsive to technological change while providing the legal certainty necessary for long-term investments in Nigeria's STEM ecosystem.

Table 7.4: Key legislative and regulatory amendments required

Legislation and Regulation	Required amendment	Reason for amendment
National Policy on Education (NPE)	Make STEM compulsory through senior secondary level. Introduce national standards for, coding, robotics, AI literacy, climate science, digital skills, entrepreneurship. Institutionalize competency-based STEM curriculum. Mandate gender inclusion targets in STEM. Create legal basis for: STEM Centres of Excellence, research clusters, innovation hubs, and dual training systems.	Current policy frameworks remain fragmented and insufficiently linked to industrialization and innovation outcomes (Federal Ministry of Education, 2018).

National Universities Commission (NUC) Act	Mandate minimum STEM investment benchmarks for universities. Require universities to establish: technology transfer offices, innovation commercialization units, industry advisory boards, centres for teaching and learning Permit flexible interdisciplinary STEM programmes. Institutionalize: micro-credentials, digital certifications, online STEM delivery. Require annual research commercialization reporting.	NUC should gain authority to: rank universities based on research impact, grants. enforce digital infrastructure standards, accredit AI/data science programmes, regulate international joint PhD programmes. The current NUC legal framework focuses largely on accreditation and quality assurance rather than innovation and commercialization (Okwuokei, 2023).
National Board for Technical Education (NBTE) Act	Transform polytechnics into applied STEM innovation institutions. Establish legal framework for: apprenticeship systems, industry-led TVET, competency certification. Enable industry co-certification of graduates. Create pathways between TVET and universities. Mandate digital and green skills in curricula.	Align technical education with: manufacturing, renewable energy, ICT, Agrictech, semiconductor/electronics industries etc
National Commission for Colleges of Education (NCCE) Act	Mandate STEM teacher specialization standards. Require digital pedagogy certification. Create a national STEM teacher licensing framework. Institutionalize continuous professional development in STEM.	Nigeria's STEM teacher shortage remains a major implementation barrier
Science and Technology Act (1977) and FMSTI Act	Redefine the Ministry's role from research administration to innovation system coordination. Legally integrate higher education, industry, research institutes, venture capital, startups. Establish mandatory national R&D targets. Create innovation commercialization mandates.	The National STI Policy already recommends reviewing these laws (National Science and Technology Policy, 2022).
Intellectual Property and Technology Transfer Reform **Patents and Designs Act** **Copyright Act** **Trademarks Act**	Higer Education IP ownership frameworks. Revenue-sharing rules for researchers. Fast-track patent systems for public research. Legal basis for spin-offs and startup commercialization. Technology licensing standards.	Weak commercialization systems currently limit translation of research into industry and economic value
Data Protection and AI Governance **Nigeria Data Protection Act,** **cybersecurity regulations,**	AI governance standards. Research ethics frameworks. Academic data protection. Algorithm accountability.	This to protect IPs

AI ethics frameworks		
Startup and Innovation Ecosystem Regulations **Nigeria Startup Act**	Deep-tech startup incentives. Higer Education startup frameworks. STEM venture capital incentives. Research commercialization grants.	Nigeria's Startup Act should be expanded and aligned with STEM strategy implementation.
Public Finance and Procurement Reforms **Public Procurement Act Amendment** **Fiscal Incentive Legislation**	fast-track procurement for research equipment and maintenance, framework contracts for laboratories, innovation procurement, startup procurement participation. Tax laws to provide: R&D tax credits, innovation tax deductions, startup investment incentives, import duty waivers for scientific equipment. New Incentive Areas: green technology, semiconductor manufacturing, biotech, renewable energy, AI industries etc	Current procurement systems significantly delay research infrastructure acquisition.
Quality Assurance and Accreditation Reforms	Establish national STEM standards for: laboratories, digital learning, research output, employability outcomes, innovation metrics. Introduce Performance-based accreditation tied to: patents, startups, publications, industry partnerships, graduate employability.	This to strengthen research and innovation in higher education

Table 7.5: New Legislation and regulations required

New Regulations	Areas of Focus	Reason
National ICT- STEM Transformation Act	The Act shall establish: National STEM Council chaired by the President or Vice President. Inter-Ministerial Coordination Mechanism (IMCM). National STEM Fund. National STEM Observatory/Data System. STEM targets for states and institutions. National STEM competitiveness indicators The Act Shall Also: define institutional responsibilities, establish implementation timelines, provide enforcement mechanisms, create annual reporting obligations, and define financing arrangements.	The umbrella legislation coordinating all STEM interventions

National Research and Innovation Fund (NRIF) Legislation	The law shall: establish an autonomous NRIF agency, provide predictable multi-year financing, allocate competitive grants, fund commercialization, support industry-university collaboration. Funding Sources The legislation could earmark: education tax contributions, telecom levies, extractive industry innovation levies, sovereign innovation allocations.	Nigeria is already moving toward a legislated national research fund (People's Gazette Nigeria, 2026).
Digital Transformation and Data Governance Laws **Digital Research Infrastructure Legislation**	Nigeria needs legal backing for: national research cloud systems, supercomputing infrastructure, research data repositories, interoperable education platforms. Required Areas research data sharing standards, cybersecurity requirements, digital identity for students/researchers, open science policies.	
Industry-University Collaboration Law	Proposed Provisions Require large firms to: invest in R&D partnerships, provide internship and apprentice quotas, support industrial PhDs, participate in curriculum design. Establish Triple Helix collaboration framework: Government, Academia, Industry.	
State STEM Implementation Laws	State STEM Development Laws, State Innovation Agency laws, STEM Education Trust Funds.	Education implementation in Nigeria is highly decentralized.
Monitoring, Accountability and Enforcement Legislation	Mandatory: annual STEM performance reporting, national STEM scorecards, independent audits, KPI-linked funding. Enforcement Mechanisms Legislation should allow: sanctions for non-compliance, withdrawal of accreditation, performance-based funding allocation	

Comprehensive legal reforms are therefore essential to:

1. institutionalizing STEM as a national development priority;
2. strengthen coordination across ministries, agencies, academia, and industry;

3. improve accountability and performance monitoring;
4. enable sustainable financing for research and innovation;
5. accelerate commercialization of research outputs;
6. modernize technical and higher education systems;
7. support digital transformation and emerging technologies;
8. attract private-sector and international investment into Nigeria's knowledge economy.

A dedicated National STEM Transformation Act, supported by amendments to key education, innovation, procurement, fiscal, and intellectual property laws, would provide the legal foundation for long-term implementation continuity beyond political cycles. Equally important is the alignment of federal and state legislation to ensure nationwide adoption and decentralized implementation across Nigeria's 36 states.

7.5 Risk Assessment and Mitigation Plan

A comprehensive Risk Assessment and Mitigation Plan is critical for the successful implementation of Nigeria's Tertiary Education ICT- driven STEM Transformation Strategy. The strategy aims to strengthen science, technology, engineering, and mathematics (STEM) education through infrastructure development, digital transformation, research enhancement, innovation ecosystems, industry partnerships, and governance reforms. Globally, large-scale education transformation programmes often fail when risks relating to governance, financing, institutional capacity, and sustainability are not adequately addressed (World Bank, 2020). In Nigeria, challenges such as weak infrastructure, unstable electricity supply, inadequate funding, research underperformance, and policy discontinuity have historically constrained tertiary education development (NUC, 2023; UNESCO, 2021).

However, implementation may face financial, institutional, political, technological, operational, and socio-economic risks. This framework identifies key risks, evaluates their potential impact and likelihood, and proposes mitigation measures, responsible institutions, and monitoring indicators

The risk framework is based on: Probability of occurrence, Potential impact on strategy outcomes Institutional preparedness Mitigation capacity and Monitoring mechanisms

Table 7.6: Risk Rating Scale

Rating	Likelihood	Impact
Low	Unlikely	Minimal disruption
Moderate	Possible	Noticeable delays/cost
High	Likely	Major disruption
Critical	Very likely	Threatens strategy success

The risks for the ICT-enabled STEM Transformation Strategy for higher education in Nigeria are grouped into:

1. Governance and Political Risks
2. Financial and Economic Risks
3. Institutional and Human Capacity Risks
4. Infrastructure and Technology Risks
5. Research and Innovation Risks
6. Social and Inclusion Risks
7. Environmental and Security Risks
8. Monitoring and Implementation Risks
9. Sustainability Risks

These categories are consistent with OECD (2021) and African Development Bank (2022) recommendations for national innovation and higher education reform Detailed Risk Assessment and Mitigation Matrix are presented in Tables 7.7 to 7.10.

Table 7.7: Strategic, Governance and Financial Risks

Risk Category	Specific Risk	Likelihood	Impact	Risk Rating	Mitigation Measures	Lead Institution(s)	Monitoring Indicator(s)
Financial	Insufficient funding and delayed budget releases	High	High	Very High	Diversify funding through TETFund, PPPs, donor support and performance-based financing	Federal Ministry of Education, Federal Ministry of Finance, Budget Office, TETFund	Annual STEM budget allocation; percentage of funds released on schedule
Political & Governance	Policy discontinuity following changes in government	Medium	High	High	Institutionalize reforms through legislation and long-term national policies	National Assembly, Federal Ministry of Education	Number of enacted policies; continuity of implementation
Institutional Coordination	Weak coordination among ministries and agencies	High	High	Very High	Establish a National ICT-STEM Steering Committee and implementation dashboard	Federal Ministry of Education, NUC, NBTE, NCCE	Frequency of coordination meetings; implementation reports
Legal & Regulatory	Delays in legislative and regulatory reforms	Medium	High	High	Fast-track legal reforms and periodic policy reviews	National Assembly, Regulatory Agencies	Number of enacted legislative amendments

Table 7.8: Human Capacity, Infrastructure and Technology Risks

Risk Category	Specific Risk	Likelihood	Impact	Risk Rating	Mitigation Measures	Lead Institution(s)	Monitoring Indicator(s)
Human Capacity	Shortage of qualified STEM academics and technical staff	High	High	Very High	Recruitment, postgraduate scholarships, diaspora engagement and CPD programmes	NUC, Universities, TETFund	Faculty recruitment rate; faculty-to-student ratio
Digital Infrastructure	Poor broadband connectivity and unreliable electricity	High	High	Very High	Expand broadband, fibre connectivity, renewable energy and backup power	Federal Ministry of Communications, NCC, REA	Percentage of institutions with reliable broadband and electricity
Technology	Rapid technological obsolescence	High	Medium	High	Technology refresh policy and lifecycle replacement plans	NUC, Institutions	Percentage of ICT infrastructure upgraded
Cybersecurity	Cyberattacks and data breaches	High	High	Very High	Cybersecurity standards, security audits, disaster recovery and staff training	NITDA, Galaxy Backbone, Institutions	Number of cyber incidents; compliance with cybersecurity standards
Sustainability	Poor maintenance of laboratories and ICT facilities	High	High	Very High	Preventive maintenance plans and dedicated maintenance funding	Institutions, TETFund	Percentage of functional laboratory and ICT equipment

Table 7.9: Academic Quality, Inclusion and Research Risks

Risk Category	Specific Risk	Likelihood	Impact	Risk Rating	Mitigation Measures	Lead Institution(s)	Monitoring Indicator(s)
Curriculum & Quality	Delays in curriculum modernization and accreditation	Medium	High	High	Accelerate curriculum review and strengthen industry participation	NUC, NBTE, NCCE, Professional Bodies	Number of revised STEM programmes
Stakeholder Resistance	Resistance to institutional change	Medium	Medium	Moderate	Change management, awareness campaigns and incentives	Institutions, Federal Ministry of Education	Adoption rate of new policies and technologies
Research & Innovation	Weak university-industry collaboration	Medium	High	High	Innovation hubs, commercialization offices and	NUC, TETFund, Private Sector	Number of collaborative research projects

					industry partnerships		
Gender & Inclusion	Low participation of women and disadvantaged groups	Medium	High	High	Scholarships, mentoring, inclusive admission policies and disability support	Federal Ministry of Education, Ministry of Women Affairs, Institutions	Female STEM enrolment; inclusion indicators

Table 7.10: Operational, Monitoring and External Risks

Risk Category	Specific Risk	Likelihood	Impact	Risk Rating	Mitigation Measures	Lead Institution(s)	Monitoring Indicator(s)
Procurement	Delays in procurement and project implementation	High	Medium	High	Digital procurement systems, framework contracts and procurement planning	Bureau of Public Procurement, Institutions	Average procurement cycle time
Monitoring & Evaluation	Weak data systems and poor performance monitoring	Medium	High	High	National STEM dashboard, institutional MIS and annual evaluations	Federal Ministry of Education, NUC, National Bureau of Statistics	Availability of real-time KPI dashboard; annual M&E reports
Regional Equity	Unequal implementation across geopolitical zones	High	High	Very High	Equity-based funding and targeted interventions for underserved regions	Federal Ministry of Education, TETFund, State Governments	Regional distribution of STEM investments
Security	Insecurity affecting institutions and infrastructure projects	Medium	High	High	Flexible implementation, remote learning and collaboration with security agencies	State Governments, Security Agencies, Institutions	Number of institutions affected by insecurity
Environmental & Climate	Climate-related disasters damaging infrastructure	Low	High	Moderate	Climate-resilient infrastructure, insurance and disaster recovery plans	Federal Ministry of Education, Institutions	Number of climate-resilient facilities; disaster recovery readiness

Nigeria's Tertiary Education ICT-Driven STEM Transformation Strategy is ambitious and potentially transformative. However, successful implementation depends on proactive identification, management, and mitigation of risks across governance, finance, infrastructure, human capacity, research, inclusion, and sustainability dimensions.

International experience demonstrates that strong governance systems, diversified financing, institutional accountability, stakeholder coordination, and continuous monitoring are essential for sustaining education reforms (World Bank, 2020; OECD, 2021). By institutionalizing these risk mitigation measures, Nigeria can significantly improve the resilience, effectiveness, and long-term sustainability of its STEM transformation agenda.

CHAPTER EIGHT

MONITORING, EVALUATION AND REPORTING

The Monitoring, and Reporting (MER) component establishes the institutional framework for tracking implementation, measuring outcomes, ensuring accountability, and supporting evidence-based decision-making across Nigeria's Higher Education system. It is built on a Logical Framework (Logframe) approach that links Inputs, Activities, Outputs, Outcomes, and Impact through Objectively Verifiable Indicators, Means of Verification, and Assumptions, and it aligns with funder requirements (FDA, TETFund, World Bank, bilateral donors) and national policy frameworks

8.1 National STEM Results Framework

The NUC shall establish a National STEM Results Framework (NSRF) — a standardized system for measuring the implementation, outputs, outcomes, and long-term impact of the STEM transformation strategy — by developing KPIs, conducting periodic monitoring and audits, and publishing performance reports.

Objectives

The Objectives of the framework shall include, to:

1. Define national STEM goals, indicators, targets, and benchmarks
2. Provide measurable indicators for institutional accountability and national reporting
3. Enable evidence-based planning, budgeting, and policy adjustment
4. Support harmonized reporting across universities, polytechnics, colleges of education, and partners
5. Track progress toward national development, staff digital competency, and entrepreneurship incubation , industrial competitiveness, and workforce readiness goals

Logframe Structure (Inputs → Activities → Outputs → Outcomes → Impact)

1. Inputs (Yr 1–2): funding, ICT infrastructure, staffing, policy frameworks, baseline studies
2. Activities (Yr 1–3): lab construction, LMS deployment, faculty training, curriculum revision, industry MoUs
3. Outputs (Yr 2–4): functional labs, ICT-enabled classrooms, revised curricula, trained faculty, active partnerships
4. Outcomes (Yr 3–5): improved student performance, research output, faculty ICT competency, gender equity, graduate employability
5. Impact (Yr 5–10): globally competitive graduates, ICT-led economic growth, improved national university rankings

Indicator Categories of the National STEM Results Framework

Input, Process, Output, Outcome, and Impact indicators, spanning infrastructure investment through national industrialization and digital-economy growth. The Input and Process indicators shall track whether resources are being committed and used as planned; Output indicators confirm institutions are actually producing results; Outcome indicators shall check whether those results translate into real capability gains (employability, research, rankings); and Impact indicators tie it all back to the national goal — industrialization, digital-economy growth and gender inclusion.

Institutional Responsibilities

i. FME coordinates the national results framework
ii. NUC, NBTE, and NCCE supervise sector-wide data collection and compliance
iii. Higher institutions establish institutional STEM monitoring.

The completed Log frame is presented below. The Logframe structures the strategy's Theory of Change across five levels — Inputs, Activities, Outputs, Outcomes, and Impact — each with Objectively Verifiable Indicators (OVIs), Means of Verification (MoV), and underlying Assumptions.

Table 8.1: Monitoring and Evaluation Framework (LOGframe) for STEM ICT-Driven Nigerian Higher Education Transformation Strategy

Level	Description	Key Indicators (OVIs)	Means of Verification	Assumptions
Inputs (Yr 1–2)	• Government/donor funding secured and disbursed • ICT hardware and software procured • STEM lecturers and technical staff selected • Policy frameworks and regulatory instruments developed • Baseline diagnostic study completed	• % of approved budget disbursed • Number of labs equipped with ICT hardware • Internet bandwidth installed (Mbps/institution) • Number of policy documents formally adopted	• Financial and procurement audits • Procurement and asset records • Baseline diagnostic report • Signed policy/regulatory instruments	• Government sustains committed funding levels • Stable national power supply • Universities support and adopt the reform agenda
Activities (Yr 1–3)	• Construction/rehabilitation of STEM laboratories • Deployment of Learning Management Systems (LMS) • Faculty ICT and pedagogical training delivered • STEM curricula revised and digitized • Industry MoUs negotiated and signed • Quarterly M&E data collection conducted	• Number of labs built vs. target • LMS adoption rate across institutions • Number of faculty training sessions held • Number of courses/curricula revised • Number of industry MoUs signed	• Progress and quarterly M&E reports • LMS usage analytics • Training attendance registers • NUC curriculum accreditation records	• Contractors deliver infrastructure on schedule • Faculty adopt new digital teaching methods • No major industrial action/strikes disrupt delivery

Outputs (Yr 2–4)	• Functional, operational STEM laboratories • ICT-enabled classrooms available for teaching • NUC-approved revised curricula in use • Faculty certified in digital pedagogy and ICT skills • Active, functioning industry partnerships	• % of labs fully operational • % classroom coverage with ICT enablement • Number of courses revised and approved • % of faculty certified • Number of active industry MoUs/partnerships	• NUC institutional audits • Physical inspection reports • Approved curriculum documents • Faculty certification records	• Labs are maintained post-commissioning • NUC approves revised curricula without material delay
Outcomes (Yr 3–5)	• Improved student academic performance in STEM • Higher research and publication output • Stronger faculty ICT competency • Gender equity gains in STEM participation • Improved graduate employability and skills match	• Average student CGPA in STEM programmes • Publications per faculty per year • Faculty ICT competency score • Female enrolment % in STEM disciplines • Graduate skill ratings; internship placement rate	• Student transcripts and academic records • Scopus/Web of Science publication data • Faculty self-assessment surveys • Employer and internship surveys • Gender equity monitoring reports	• Improved learning environment is sustained • No reversal of STEM education policy • Economy absorbs STEM graduates into relevant employment
Impact (Yr 5–10)	• Globally competitive STEM graduates produced • ICT-led economic growth and industrial competitiveness • Improved national and international university rankings	• Graduate employment rate • Number of patents and innovations registered • STEM contribution to national GDP share • QS / Times Higher Education ranking position	• National Bureau of Statistics labour data • National patent registry • National accounts / GDP statistics • Global university ranking publications	• Macroeconomic stability is maintained • Brain drain of skilled graduates is mitigated

8.2 Annual Performance Contracts

All participating tertiary institutions and implementing agencies shall operate under Annual Performance Contracts linking clearly defined STEM transformation targets to accountability indicators, in order to strengthen institutional accountability, promote result-oriented management, and link funding and incentives to measurable performance.

Core Features of annual performance contracts

Annual targets, KPIs, institutional deliverables, funding commitments, reporting timelines, risk mitigation strategies, and expected outcomes.

Key Performance Areas

ICT infrastructure, digital teaching and learning, STEM enrolment growth, gender inclusion, research and innovation, industry collaboration, graduate employability, staff digital competency, and entrepreneurship incubation.

Incentives and Accountability

i. Strong performers may receive competitive grants, additional infrastructure support, research funding, and recognition
ii. Underperformers face corrective action plans, technical support, and enhanced oversight

Implementation

Contracts signed annually between government agencies and institutional leadership, with standardized annual assessments informing national funding and policy decisions

8.3 Data Governance and EMIS

Government shall establish a robust STEM Data Governance and Education Management Information System (EMIS) framework to support reliable data collection, digital reporting, policy planning, institutional benchmarking, and evidence-based decision-making.

EMIS Architecture

Institutional data dashboards, national STEM data repositories, real-time reporting systems, digital analytics and visualization tools, AI-enabled forecasting, and integrated student/staff/research/infrastructure databases

Key Data Domains

Enrolment and graduation, gender participation, faculty qualifications, ICT infrastructure, research outputs and patents, entrepreneurship activity, labour market outcomes, and funding utilization

Governance Principles

Data accuracy and integrity, standardized reporting formats, interoperability, cyber security and data protection, ethical use, and regulatory compliance

Institutional Arrangements and Digital Reporting

i. Institutions shall establish STEM Data Management Units; NUC and regulatory agencies shall coordinate harmonization and quality assurance; the national EMIS shall integrates with existing systems
ii. All institutions shall transition from manual to digital reporting platforms for efficiency, transparency, and real-time monitoring

8.4 Mid-Term and End-Term Reviews

The strategy shall undergo periodic Mid-Term and End-Term Reviews to assess implementation progress, policy effectiveness, institutional impact, and national transformation outcomes, recommending corrective measures and ensuring alignment with national priorities.

Mid-Term Review

i. This shall be conducted halfway through the implementation cycle; it will assesses progress toward targets, institutional compliance, resource efficiency, and stakeholder feedback
ii. It supports policy recalibration, adjustment of priorities, target revision, and strengthened institutional support

End-Term Review

This review shall evaluate overall achievement of strategic goals, long-term impacts, sustainability of reforms, national competitiveness, and lessons for future policy.

Methodology and Reporting

i. Independent evaluations, institutional self-assessments, stakeholder consultations, benchmarking, field verification, and data analytics
ii. Findings shall be published in national performance reports and incorporated into future development planning cycles

Stakeholder Participation

Government ministries, regulatory bodies, higher institutions, industry partners, development partners, academia, and civil society.

Project-Level Monitoring (PIU) Milestones

i. Dec 2026: STEM strategy validated; 5 capacity-building activities reaching 250+ participants from 10+ universities; small-grants procedures manual prepared
ii. Dec 2026 (later milestone): LMO feasibility study prepared; 5 universities benefiting from small grants with ≥30% female beneficiaries
iii. Dec 2027: LMO operational; 10 universities benefiting from small grants with ≥30% female beneficiaries
iv. Gender-promotion commitments monitored specifically in partnership with GIL

CHAPTER NINE

FINANCIAL PLAN AND INVESTMENT FRAMEWORK

9.1 Introduction

The Financial Plan and Investment Framework provides a roadmap for mobilizing, allocating, and managing financial resources in a transparent, accountable, and results-oriented manner. It aligns investment priorities with the phased implementation of the ICT-STEM Transformation Strategy while promoting public-private partnerships, donor coordination, competitive research funding, institutional cost-sharing, and performance-based financing. The framework also emphasizes value for money, financial sustainability, efficient resource utilization, and robust monitoring and evaluation to ensure that investments generate measurable improvements in teaching, learning, research, innovation, graduate employability, and national economic competitiveness.

Consistent with international best practices for financing higher education transformation, the framework seeks to leverage domestic public investment to attract additional private and international financing, thereby expanding the overall resource envelope available for Nigeria's tertiary education sector. By combining multiple financing instruments with strong governance and accountability mechanisms, the Financial Plan and Investment Framework will provide the financial foundation necessary to achieve a globally competitive, digitally enabled, inclusive, and innovation-driven ICT-STEM ecosystem that supports Nigeria's aspirations for sustainable economic growth and technological advancement.

The successful implementation of Nigeria's ICT-STEM Transformation Strategy for Higher Education shall require a sustainable, diversified, and predictable financing framework capable of supporting long-term investments in digital infrastructure, modern laboratories, research and innovation, human capital development, institutional reforms, and quality assurance. Given the scale of transformation envisioned, reliance on a single funding source is neither feasible nor sustainable.

A sustainable ICT-STEM transformation programme for Nigeria's higher education sector adopts a **blended or multi-funding model**, recognizing that no single funding source can finance the scale of investment required. Government focuses on policy, public infrastructure, and recurrent support, while development partners, industry, philanthropy, and beneficiary institutions contribute strategically according to their comparative advantages. The percentage contributions Table 9.1 to 9.3 represent a realistic funding framework that needs to be adapted based on programme priorities and negotiations with partners. A multi-source funding model is proposed to include but not limited to:

1. **Government Allocations:**
   Federal and state education budgets.
2. **Private Sector:**
   Incentives for co-investment in labs, scholarships, and innovation hubs.
3. **International Development Partners:**
   Grants and technical assistance from UNESCO, World Bank, AfDB, and bilateral donors.

4. **National STEM Innovation Fund:**
   Dedicated fund for university-led startups and commercialization.
5. **Institutional budgets and endowments**

Table 9.1: Multi-Funding Model for ICT and Infrastructure Investments

Key Expenditure Item	Federal Govt. (%)	State Govt. (%)	TETFund (%)	Private Sector (%)	Development Partners (%)	Institutions (%)	Foundations/ Alumni (%)	Total (%)
ICT infrastructure (broadband, cloud, campus networks)	25	10	25	20	15	3	2	100
Smart classrooms and digital learning facilities	20	10	35	15	15	3	2	100
STEM laboratories and research equipment	20	5	40	10	20	3	2	100
Equipment maintenance and service contracts	20	10	30	20	5	10	5	100
Digital libraries and e-learning resources	20	5	35	10	20	5	5	100

Table 9.2: Multi-Funding Model for Research, Innovation and Human Capacity Development

Key Expenditure Item	Federal Govt. (%)	State Govt. (%)	TETFund (%)	Private Sector (%)	Development Partners (%)	Institutions (%)	Foundations / Alumni (%)	Total (%)
Research grants and innovation funding	20	5	25	25	20	2	3	100
Centres of Excellence and Research Hubs	20	10	30	15	20	2	3	100
Faculty capacity building and CPD	15	5	40	10	25	3	2	100
Student scholarships and talent development	15	10	20	20	25	5	5	100
Entrepreneurship and innovation ecosystem	10	5	20	40	15	5	5	100
AI, Robotics and Emerging Technology Centres	15	5	30	30	15	3	2	100

Table 9.3: Multi-Funding Model for Governance, Digital Platforms and Overall Financing

Key Expenditure Item	Federal Govt. (%)	State Govt. (%)	TETFund (%)	Private Sector (%)	Development Partners (%)	Institutions (%)	Foundations/ Alumni (%)	Total (%)
National STEM digital platforms and data systems	30	5	25	15	20	3	2	100
Monitoring, evaluation and quality assurance	30	10	25	5	20	5	5	100
Policy implementation, governance and institutional reforms	40	15	20	5	15	3	2	100
Overall indicative contribution across the programme	**23**	**8**	**29**	**17**	**19**	**3**	**1**	**100**

These percentage allocations are suitable for a World Bank/AfDB-style financing framework**,** where TETFund and the Federal Government provide the core domestic financing**,** development partners support transformational investments and reforms**,** and private sector participation is concentrated on innovation, commercialization, and digital technologies.

9.2 Sustainability and Exit Strategy

Introduction

The long-term success of Nigeria's ICT-enabled STEM Transformation Strategy for Tertiary Education depends not only on effective implementation but also on the sustainability of investments, institutional systems, policy reforms, and innovation ecosystems beyond the initial implementation period. Sustainability ensures that the gains achieved through infrastructure modernization, digital transformation, research development, faculty capacity building, and innovation support are maintained, expanded, and institutionalized over time.

An effective sustainability and exit strategy is therefore essential to reduce dependency on external funding, strengthen institutional ownership, ensure continuity across political transitions, and build resilient systems capable of adapting to future technological and socioeconomic changes. According to the World Bank (2021), sustainable education reform requires long-term financing systems, strong institutional capacity, local ownership, and continuous policy commitment.

The sustainability framework outlined below focuses on financial sustainability, institutional sustainability, technological sustainability, governance continuity, human capital retention, research ecosystem resilience, and development partner transition mechanisms.

Objectives of the Sustainability and Exit Strategy

The sustainability and exit strategy seeks to:

1. Ensure long-term continuity of ICT-enabled STEM reforms
2. Strengthen institutional ownership and accountability
3. Reduce overdependence on donor and external financing
4. Institutionalize governance and policy reforms
5. Maintain and upgrade infrastructure and digital systems
6. Sustain research and innovation ecosystems
7. Retain and continuously develop human capital
8. Promote financial resilience and diversified funding
9. Ensure continuity beyond political and administrative transitions

These objectives align with recommendations by UNESCO (2021), which emphasized that sustainability in higher education reform requires institutional integration, domestic financing, and long-term strategic planning.

Financial Sustainability Strategy

A. Diversification of Funding Sources

Long-term sustainability requires reducing reliance on a single funding source by establishing diversified financing mechanisms.

Key Financing Sources

1. Federal government budget allocations
2. State government counterpart funding
3. Public-private partnerships (PPPs)
4. Research commercialization revenue
5. Innovation and technology licensing income
6. Endowment funds
7. Alumni contributions
8. Competitive international research grants
9. Venture capital and innovation financing
10. Institutional internally generated revenue (IGR)

The African Development Bank (2022) recommends diversified financing models for African higher education systems to improve resilience and long-term sustainability.

B. Establishment of National STEM Transformation Funds

Nigeria shall establish dedicated long-term financing mechanisms such as:

1. National STEM Transformation Fund

2. Research and Innovation Endowment Fund
3. Digital Infrastructure Sustainability Fund
4. AI and Emerging Technology Development Fund

These funds shall be supported through:

1. Annual appropriations
2. Telecommunications and digital economy levies
3. Private sector contributions
4. Development partner co-financing
5. Innovation investment mechanisms

C. Performance-Based Financing

Funding allocation shall increasingly shift toward performance-based systems linked to:

1. Research productivity
2. Graduate employability
3. Innovation outputs
4. Industry partnerships
5. Digital transformation indicators
6. Inclusion and gender equity targets

Performance-based financing encourages accountability, efficiency, and institutional competitiveness (World Bank, 2021).

9.3 Institutional Sustainability Strategy

A. Institutionalization of Reforms

Sustainability requires integrating reforms into permanent institutional structures, policies, and operational systems.

Key Measures

1. Embedding ICT and STEM priorities into institutional strategic plans
2. Mainstreaming digital learning systems into regular academic operations
3. Establishing permanent STEM innovation units
4. Integrating research commercialization structures into university governance
5. Institutionalizing continuous curriculum review systems

The Organisation for Economic Co-operation and Development (2021) noted that reforms are more sustainable when integrated into core institutional governance systems rather than operating as temporary projects.

B. Strengthening Institutional Autonomy

Institutions shall be empowered to:

1. Generate and manage revenue
2. Establish industry partnerships
3. Commercialize innovations
4. Recruit specialized STEM talent
5. Develop independent sustainability plans

Improved institutional autonomy supports long-term adaptability and resilience.

C. Digital Governance and Data Systems

Sustainability requires permanent digital governance systems for:

1. Institutional data management
2. Monitoring and evaluation
3. Digital administration
4. Learning management systems
5. Research management platforms

Continuous investment in cybersecurity and digital maintenance systems is also essential.

9.4 Human Capital Sustainability Strategy

A. Faculty Retention and Development

Sustaining transformation outcomes requires continuous investment in academic and technical personnel.

Key Measures

1. Competitive remuneration systems
2. Continuous professional development programmes
3. Research grants and incentives
4. International collaboration opportunities
5. Career progression pathways
6. Industry engagement opportunities

According to UNESCO (2021), sustained faculty development is essential for maintaining education quality and innovation capacity.

B. STEM Talent Pipeline Development

Nigeria shall establish long-term systems to continuously develop:

1. STEM graduates
2. Researchers
3. Innovation entrepreneurs

4. Technical workforce specialists
5. AI and digital technology experts

This includes strengthening postgraduate and doctoral education systems.

C. Diaspora Engagement and Knowledge Transfer

The sustainability strategy shall incorporate:

1. Visiting scholar programmes
2. Diaspora research collaboration networks
3. Joint supervision arrangements
4. Virtual teaching and mentorship platforms

Diaspora engagement can help address expertise gaps and strengthen international competitiveness.

9.5 Infrastructure Sustainability Strategy

A. Maintenance and Upgrade Systems

Long-term sustainability requires structured maintenance systems for:
1. ICT infrastructure
2. Laboratories and research equipment
3. Smart classrooms
4. Renewable energy systems
5. Data centres and servers

Institutions shall be required to establish:
1. Preventive maintenance plans
2. Equipment replacement schedules
3. Technical support units
4. Infrastructure renewal funds

B. Renewable Energy Integration

To reduce operational costs and improve sustainability, institutions should invest in:
1. Solar energy systems
2. Smart energy management technologies
3. Energy-efficient digital infrastructure

The United Nations Development Programme (2022) highlighted renewable energy integration as critical for sustainable digital infrastructure in developing countries.

9.6 Research and Innovation Sustainability

A. Commercialization of Research Outputs

Research sustainability requires stronger commercialization ecosystems through:

1. Patent development
2. Technology transfer offices
3. Startup incubation systems
4. Industry-sponsored research
5. Innovation venture funds

Commercialization can generate institutional revenue while strengthening national innovation systems.

B. Long-Term Research Financing

Sustainable research systems require:
1. National competitive research grants
2. Research endowment funds
3. Public-private research partnerships
4. International research collaboration funding

The World Bank (2020) emphasized that long-term research financing is essential for building innovation-driven economies.

9.7 Governance and Policy Continuity Strategy

A. Legislative and Regulatory Backing

To ensure continuity across political transitions, major reforms should be institutionalized through:

1. National legislation
2. Regulatory frameworks
3. Long-term policy instruments
4. Multi-year financing commitments

Legislative backing reduces the risk of policy reversals and implementation discontinuity.

B. National Coordination Structures

Permanent coordination mechanisms shall include:

1. National STEM Transformation Council
2. Inter-Ministerial Coordination Mechanism (IMCM)
3. Institutional implementation units
4. Independent monitoring and evaluation bodies

These systems help maintain continuity and accountability.

C. Stakeholder Ownership and Participation

Sustainability improves when stakeholders actively participate in implementation.

Key stakeholders include:

1. Government agencies
2. Tertiary institutions
3. Private sector organizations
4. Professional associations
5. Development partners
6. Students and academic staff
7. Civil society organizations

Broad stakeholder ownership strengthens policy continuity and public support.

Development Partner Exit Strategy

A. Gradual Transition to Domestic Financing

Development partner support shall gradually transition toward domestic ownership through:

1. Declining external financing ratios over time
2. Increasing government counterpart contributions
3. Expansion of institutional revenue generation
4. Local capacity transfer

B. Capacity Transfer and Institutional Strengthening

Before project completion, development partners shall ensure:

1. Local technical capacity development
2. Knowledge transfer mechanisms
3. Institutional systems strengthening
4. Local ownership of digital and research systems

The Organisation for Economic Co-operation and Development (2020) emphasized that sustainable development assistance must prioritize institutional strengthening and local ownership.

C. Exit Readiness Indicators

Development partner exit shall be based on measurable indicators such as:

1. Institutional financial sustainability
2. Operational digital infrastructure
3. Local technical expertise availability
4. Functional governance systems
5. Sustainable research financing
6. Policy continuity mechanisms

9.8 Sustainability Risk Mitigation Measures

Ensuring the long-term sustainability of Nigeria's ICT-STEM Transformation Strategy requires proactive measures to identify, manage, and mitigate financial, institutional, technological, and operational risks. Sustainability is strengthened through diversified financing, strong governance and accountability systems, continuous capacity building, regular maintenance and upgrading of ICT and laboratory infrastructure, institutional ownership, and active partnerships with industry and development partners. The strategy also emphasizes policy continuity, performance-based monitoring, periodic reviews, and evidence-based decision-making to ensure that investments remain relevant, resilient, and capable of delivering lasting improvements in STEM education, research, innovation, and workforce development despite changing economic and technological conditions.

Table 9.4: Sustainability Risk Mitigation Measures

Sustainability Risk	Mitigation Strategy
Political transitions	Legislative backing and multi-party ownership
Funding instability	Diversified financing systems
Infrastructure deterioration	Preventive maintenance systems
Brain drain	Competitive incentives and career development
Weak institutional ownership	Stakeholder engagement and accountability
Technology obsolescence	Continuous upgrading and innovation investment
Donor dependency	Domestic financing transition plans

The sustainability and exit strategy for Nigeria’s ICT-enabled STEM Transformation Strategy is designed to ensure that transformation outcomes remain resilient, institutionalized, and financially viable long after the initial implementation period. Sustainable transformation requires strong domestic ownership, diversified financing systems, institutional capacity building, policy continuity, infrastructure maintenance, human capital retention, and long-term innovation ecosystems.

While development partners can play a catalytic role during implementation, the ultimate success of the strategy will depend on Nigeria’s ability to build self-sustaining institutions, resilient financing structures, and nationally owned innovation systems. Effective sustainability planning will ensure that the investments made in ICT-enabled STEM transformation continue to generate long-term benefits for economic diversification, technological advancement, industrial competitiveness, and sustainable national development.

CHAPTER TEN

STAKEHOLDER ENGAGEMENT AND COMMUNICATION STRATEGY

10.1 Introduction

Effective stakeholder engagement and communication are critical to the success of Nigeria's ICT-STEM transformation in higher education. According to UNESCO, sustainable STEM reforms require broad institutional collaboration, knowledge-sharing mechanisms, and participatory governance structures that promote innovation and inclusion.[102] Similarly, the World Bank emphasizes that successful education transformation in developing countries depends heavily on stakeholder ownership, industry participation, and coordinated policy implementation.[103]

Nigeria's tertiary education ecosystem involves multiple actors including ministries, regulatory agencies, universities, polytechnics, colleges of education, research institutes, private sector organizations, development partners, faculty members, students, and local communities. Consequently, stakeholder engagement must move beyond one-time consultations toward continuous collaboration, co-creation, and accountability.[104]

The Stakeholder Engagement and Communication Strategy for the STEM ICT-driven transformation provide is a structured framework for which the strategy shall be used to identify, inform, engage, consult, and collaborate with all groups that shall influence or shall be affected by the STEM ICT-driven transformation. The strategy seeks to ensure that stakeholders:

a. Understand the vision and goals of the transformation;
b. Participate actively in planning and implementation;
c. Contribute expertise, resources, and support;
d. Build ownership and sustainability of reforms; and
e. Promote transparency, accountability, and collaboration.

10.2 Objectives of the Stakeholder Engagement Strategy

The stakeholder engagement and communication strategy is aimed to:

1. Build national consensus around the ICT-STEM transformation strategy;
2. Promote stakeholder commitment, ownership and participation;
3. Strengthen coordination among ministries, agencies, and institutions;

[102] UNESCO. (2021). Engineering for Sustainable Development: Delivering on the Sustainable Development Goals. Paris: UNESCO.
[103] World Bank. (2020). The Skills Balancing Act in Sub-Saharan Africa: Investing in Skills for Productivity, Inclusivity, and Adaptability. Washington, DC: World Bank.
[104] Bryson, J. M. (2018). Strategic Planning for Public and Nonprofit Organizations. Hoboken, NJ: Wiley.

4. Enhance transparency and accountability;
5. Facilitate industry-academia-government-society collaboration;
6. Improve public awareness and support for STEM reforms;
7. Encourage inclusion of women, underserved populations and regional balance;
8. Support continuous feedback and adaptive implementation;
9. Mobilize financial, technical and policy support;
10. Reduce resistance to organizational and technological changes
11. Facilitate participatory decision-making

These objectives align with the participatory governance principles recommended by the OECD for digital transformation in higher education systems. [105]

10.3 Key Stakeholder Groups

The successful implementation of Nigeria's ICT-STEM Transformation Strategy for higher education depends on the active participation and collaboration of a diverse range of stakeholders as presented in Table 10.1. These stakeholders contribute complementary expertise, resources, policy support, and implementation capacity necessary to achieve the strategy's objectives. Government ministries and regulatory agencies provide strategic leadership, policy direction, governance, and quality assurance, while tertiary institutions, research institutes, and academic staff are responsible for implementing curriculum reforms, conducting research, and driving innovation. The private sector and industry ensure that STEM education remains responsive to labour market needs through partnerships, internships, research commercialization, and technology transfer.[106] Equally important are STEM professional associations and academic societies, which provide professional standards, accreditation support, curriculum development expertise, continuing professional development, and policy advocacy to enhance the quality and relevance of STEM education. Students serve as both beneficiaries and active partners in shaping innovative learning environments, while development partners, civil society organizations, diaspora academics, communities, and the media contribute financial support, technical expertise, advocacy, public awareness, and accountability. Establishing effective engagement and communication mechanisms for these stakeholder groups will foster shared ownership, strengthen coordination, facilitate evidence-based decision-making, and ensure the long-term sustainability of Nigeria's ICT-STEM transformation agenda.[107]

[105] OECD. (2021). Digital Transformation and the Futures of Higher Education. Paris: OECD Publishing.
[106] World Bank. (2020). The Skills Balancing Act in Sub-Saharan Africa: Investing in Skills for Productivity, Inclusivity, and Adaptability. Washington, DC: World Bank.
[107] Bryson, J. M. (2018). Strategic Planning for Public and Nonprofit Organizations. Hoboken, NJ: Wiley; UNESCO. (2021). Engineering for Sustainable Development: Delivering on the Sustainable Development Goals. Paris: UNESCO; OECD. (2021). Digital Transformation and the Futures of Higher Education. Paris: OECD Publishing.

Table 10.1: Key Stakeholder Groups for Nigeria's ICT-STEM Transformation in Tertiary Education

Stakeholder Group	Key Institutions/Organizations	Primary Roles and Interests	Engagement and Communication Strategy
Federal Government Ministries	Federal Ministry of Education (FME); Federal Ministry of Communications, Innovation and Digital Economy; Federal Ministry of Science, Technology and Innovation; Federal Ministry of Finance; Federal Ministry of Budget and Economic Planning	Policy formulation, strategic leadership, funding, national coordination, inter-ministerial collaboration	Cabinet briefings, policy dialogues, steering committee meetings, quarterly progress reports, inter-ministerial coordination forums
Regulatory and Quality Assurance Agencies	National Universities Commission (NUC); National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); National Information Technology Development Agency (NITDA); Nigerian Communications Commission (NCC); National Board for Technology Incubation (NBTI)	Regulation, accreditation, quality assurance, ICT standards, monitoring compliance	Technical working groups, regulatory consultations, joint policy development, annual review meetings
Funding and Research Agencies	TETFund; National Research Fund; National Information Technology Development Fund; Bank of Industry (BoI); Nigerian Sovereign Investment Authority (NSIA)	Financing infrastructure, research, innovation, scholarships, commercialization	Investment forums, donor coordination meetings, performance reporting, funding review workshops
State Governments	State Ministries of Education; State ICT Agencies; State Science and Technology Ministries	State-level implementation, infrastructure provision, co-financing, policy alignment	Regional coordination meetings, governors' forums, state implementation committees
Universities, Polytechnics and Colleges of Education	Federal, State and Private Universities; Polytechnics; Colleges of Education	Curriculum implementation, research, innovation, digital transformation, workforce development	Institutional implementation committees, vice-chancellors'/rectors' forums, annual institutional reviews
Research Institutes and Centres of Excellence	National research institutes, specialized STEM centres, innovation hubs, Centres of Excellence	Applied research, technology development, commercialization, capacity building	Research networks, collaborative projects, innovation forums, annual research conferences
Academic Staff and Institutional Leadership	Vice-Chancellors, Rectors, Provosts, Governing Councils, Faculty, ICT Directors, Librarians	Leadership, institutional change management, teaching, mentoring, research	Leadership retreats, faculty consultations, professional development workshops, newsletters
Students and Student Organizations	National Association of Nigerian Students (NANS); Student Union Governments; STEM clubs; Innovation hubs; Entrepreneurship clubs	Beneficiaries, innovation, entrepreneurship, peer advocacy, feedback	Student town halls, social media engagement, digital feedback platforms, hackathons, innovation competitions
STEM Professional Associations	Nigerian Society of Engineers; Council for the Regulation of Engineering in Nigeria; Nigeria	Curriculum review, professional standards, accreditation support,	Representation on advisory boards, curriculum review

and Academic Societies	Computer Society; Computer Professionals Registration Council of Nigeria; Chemical Society of Nigeria; Science Association of Nigeria; Nigerian Academy of Science; Nigerian Institute of Physics	certification, continuing professional development (CPD), policy advocacy, mentorship, industry linkages	committees, joint conferences, technical consultations, CPD programmes, policy dialogues
Private Sector and Industry	ICT companies, telecommunications firms, manufacturing industries, energy companies, fintech firms, startups, innovation accelerators, chambers of commerce	Skills development, internships, employment, research partnerships, commercialization, investment	Industry advisory boards, PPP forums, employer roundtables, innovation challenges, internship partnerships
Development Partners and International Organizations	World Bank; African Development Bank; UNESCO; UNICEF; United Nations Development Programme; bilateral development agencies	Technical assistance, financing, capacity development, international benchmarking, monitoring and evaluation	Development partner forums, joint missions, donor coordination meetings, annual programme reviews
Diaspora and International Academic Partners	Nigerian academics in the diaspora; international universities; global research networks; professional societies	Research collaboration, faculty exchange, mentorship, technology transfer, international partnerships	Virtual collaboration platforms, visiting scholar programmes, joint research grants, international conferences
Civil Society Organizations and Foundations	NGOs, education advocacy groups, youth organizations, women in STEM organizations, philanthropic foundations	Community engagement, advocacy, inclusion, public awareness, social accountability	Stakeholder consultations, public campaigns, community outreach, policy advocacy forums
Communities and Traditional Institutions	Community leaders, traditional rulers, parents' associations, local education committees	Community ownership, local support, social inclusion, sustainability	Community forums, stakeholder dialogues, local awareness campaigns, radio programmes
Media Organizations	Print media, television, radio, online media, digital influencers	Public awareness, information dissemination, transparency, accountability	Press briefings, media partnerships, newsletters, documentaries, social media campaigns

10.4 Strategic Activities

Given the diverse range of stakeholders involved, communication shall be continuous, transparent, inclusive, and participatory throughout the planning, implementation, monitoring, and evaluation phases. Strategic engagement activities (Table 10.2) including stakeholder forums, policy dialogues, institutional committees, digital communication platforms, public awareness campaigns, industry partnerships, and regular progress reporting shall promote collaboration, strengthen institutional ownership, and facilitate evidence-based decision-making.[108]

[108] Bryson, J. M. (2018). Strategic Planning for Public and Nonprofit Organizations. Hoboken, NJ: Wiley.

Table 10.2: Key Stakeholder Communication and Engagement Activities and Expected Outcomes for Nigeria's ICT-STEM Transformation in Higher Education

Strategic Activity	Description	Primary Stakeholders	Expected Outcomes
Establish a National ICT-STEM Stakeholder Forum	Create a national multi-stakeholder platform for dialogue, coordination, and policy guidance.	Federal Government, Regulatory Agencies, Tertiary Institutions, Industry, Development Partners, Professional Associations	Improved national coordination, shared ownership of reforms, and stronger policy alignment.
Develop a Stakeholder Engagement and Communication Plan	Prepare a comprehensive communication strategy outlining stakeholders, communication channels, key messages, and engagement schedules.	All stakeholders	Consistent communication, increased stakeholder awareness, and improved transparency throughout implementation.
Constitute Institutional ICT-STEM Transformation Committees	Establish stakeholder engagement committees within tertiary institutions to coordinate local implementation and communication.	Universities, Polytechnics, Colleges of Education, Students, Faculty	Enhanced institutional coordination, stronger internal communication, and increased stakeholder participation.
Conduct National and Regional Stakeholder Consultations	Organize consultative forums during planning, implementation, monitoring, and review phases.	Government, Academia, Industry, Students, Civil Society, Professional Bodies	Increased stakeholders buy-in, improved policy relevance, and stronger collaborative decision-making.
Strengthen Industry–Academia Engagement	Establish industry advisory boards, internship partnerships, collaborative research, and innovation programmes.	Industry, Universities, Professional Associations, Students	Improved curriculum relevance, increased employability, enhanced research commercialization, and stronger innovation ecosystems.
Engage STEM Professional Associations	Involve professional bodies in curriculum development, accreditation, policy review, certification, and continuing professional development.	Professional Associations, Regulatory Agencies, Universities	Improved quality assurance, professional standards, curriculum modernization, and workforce readiness.
Implement Student Engagement Programmes	Promote student participation through innovation competitions, hackathons, entrepreneurship programmes, student representation, and digital feedback platforms.	Students, Student Unions, Innovation Hubs	Increased student ownership, innovation culture, entrepreneurship, and responsiveness to student needs.
Launch a National ICT-STEM Communication Campaign	Conduct nationwide awareness campaigns using television, radio, newspapers, websites, and social media.	General Public, Media, Communities, Students	Increased public awareness, stakeholder support, and national visibility of the transformation agenda.
Develop a Digital Stakeholder Engagement Platform	Create an online portal for information sharing, consultations, progress reporting, and stakeholder feedback.	All Stakeholders	Improved access to information, real-time engagement, greater transparency, and evidence-based decision-making.

Publish Regular Progress Reports and Dashboards	Disseminate implementation progress, performance indicators, success stories, and lessons learned through annual reports and digital dashboards.	Government, Development Partners, Institutions, Public	Increased accountability, transparency, stakeholder confidence, and informed decision-making.
Organize Annual ICT-STEM Transformation Conferences	Hold annual national conferences to review progress, showcase innovations, share experiences, and strengthen partnerships.	Government, Academia, Industry, Professional Associations, Development Partners	Knowledge sharing, stronger partnerships, policy refinement, and dissemination of best practices.
Strengthen Development Partner Coordination	Establish regular donor coordination meetings to align investments, technical assistance, and implementation support.	Development Partners, Government, Research Institutions	Improved resource mobilization, reduced duplication of efforts, and harmonized donor support.
Promote Community and Civil Society Engagement	Engage local communities, NGOs, traditional institutions, and advocacy groups through outreach programmes and public consultations.	Communities, Civil Society Organizations, Traditional Leaders	Greater social inclusion, community ownership, public trust, and sustainability of reforms.
Implement Change Management and Capacity Building Programmes	Provide communication, leadership, digital literacy, and change management training for institutional leaders and staff.	Institutional Leadership, Faculty, ICT Staff, Administrators	Reduced resistance to change, enhanced implementation capacity, and improved institutional readiness.
Establish Feedback and Grievance Redress Mechanisms	Develop structured systems for collecting stakeholder feedback, addressing concerns, and resolving implementation issues promptly.	All Stakeholders	Improved stakeholder satisfaction, stronger trust, adaptive management, and continuous improvement.

Stakeholder engagement and communication are critical components of Nigeria's ICT driven-STEM transformation in higher education. Sustainable transformation requires continuous collaboration among government, academia, industry, students, communities, and development partners. By adopting participatory governance frameworks, digital communication systems, localized engagement strategies, and industry partnerships, Nigeria can build a resilient ICT-STEM ecosystem capable of driving innovation, economic diversification, and national competitiveness in the digital economy. As emphasized by UNESCO[109] and the OECD[110], inclusive stakeholder engagement enhances reform sustainability, strengthens institutional ownership, and improves long-term development outcomes.

[109] UNESCO. (2021). Engineering for Sustainable Development: Delivering on the Sustainable Development Goals. Paris: UNESCO.
[110] OECD. (2021). Digital Transformation and the Futures of Higher Education. Paris: OECD Publishing.

CONCLUSION AND CALL TO ACTION

Conclusion

Nigeria stands at a defining moment in its national development trajectory. The future competitiveness, economic resilience, technological sovereignty, and social transformation of the nation will depend largely on the strength and relevance of its tertiary education system. An ICT-driven STEM Transformation Strategy provides Nigeria with a historic opportunity to reposition its universities, polytechnics, colleges of education, and research institutes as engines of innovation, industrialization, digital competitiveness, and sustainable development.

The strategy recognizes that traditional approaches to higher education are no longer sufficient in a rapidly evolving global knowledge economy driven by artificial intelligence, digital technologies, advanced manufacturing, biotechnology, renewable energy, data science, and innovation ecosystems. Nigeria must therefore transition from a largely theory-oriented education model to a dynamic, technology-enabled, research-driven, industry-connected, and globally competitive STEM ecosystem.

The transformation agenda outlined in this strategy seeks to achieve multiple interconnected objectives: modernizing ICT infrastructure; reforming curricula to align with emerging technologies and labour market demands; strengthening research and innovation systems; expanding postgraduate and doctoral education; promoting entrepreneurship and industry partnerships; improving governance and institutional coordination; deepening inclusion and gender equity; and strengthening regional and international collaboration. Together, these reforms shall contribute significantly to national productivity, employment generation, economic diversification, digital transformation, environmental sustainability, and improved quality of life for Nigerians.

Importantly, the strategy also acknowledges that sustainable transformation cannot occur without strong institutions, stable financing mechanisms, effective regulatory frameworks, accountability systems, and long-term political commitment. The implementation of this strategy will therefore require coordinated action across federal and state governments, tertiary institutions, regulatory agencies, the private sector, development partners, professional associations, research organizations, civil society, and the Nigerian diaspora.

The success of the ICT-driven STEM Transformation Strategy shall not be measured solely by infrastructure investments or policy declarations, but by measurable outcomes such as improved graduate employability, increased research productivity, commercialization of innovations, strengthened digital competencies, enhanced global rankings of Nigerian institutions, increased participation of women and marginalized groups in STEM fields, and stronger linkages between academia and national development priorities.

If effectively implemented, this strategy has the potential to transform Nigeria into a regional and global hub for digital innovation, scientific research, technological entrepreneurship, and human capital development. It can enable Nigeria to harness the demographic advantage of its youthful population while positioning the country to compete effectively in the Fourth Industrial Revolution and the emerging global digital economy

Call to Action

The time for incremental reforms has passed. Nigeria must now pursue bold, coordinated, and sustained action to transform its tertiary education system into a globally competitive ICT-driven STEM ecosystem.

The Federal Government of Nigeria, through the Federal Ministry of Education, must provide strong national leadership, policy consistency, and adequate funding to drive implementation. Regulatory agencies including the National Universities Commission, National Board for Technical Education, and National Commission for Colleges of Education must accelerate reforms that support innovation, curriculum modernization, quality assurance, digital transformation, and institutional accountability.

State governments must prioritize investment in STEM infrastructure, digital connectivity, and institutional capacity building across state-owned tertiary institutions. Institutional leaders must embrace transformational governance, strengthen research culture, foster interdisciplinary collaboration, and build strategic partnerships with industry and international institutions.

The private sector and industry stakeholders must move beyond passive engagement and become active partners in curriculum development, research funding, internship programmes, technology transfer, commercialization of innovations, and workforce development. Professional associations and industry bodies must contribute to standards development, mentorship, accreditation support, and labour market alignment.

Development partners, donor agencies, and international organizations should align technical and financial support toward long-term capacity building, research ecosystems, digital infrastructure expansion, and institutional sustainability rather than fragmented short-term interventions.

Academic staff, researchers, and students must also play a central role by embracing innovation, entrepreneurship, digital literacy, interdisciplinary research, and lifelong learning. Nigerian researchers in the diaspora should be strategically engaged through collaborative research networks, joint doctoral programmes, visiting scholar initiatives, and technology transfer partnerships.

Most importantly, this strategy demands a national commitment to accountability, continuity, inclusivity and implementation discipline. Policies must move beyond paper commitments to measurable action supported by transparent monitoring and evaluation systems, sustainable financing mechanisms, and performance-based implementation frameworks.

Nigeria possesses the human talent (both men and women alike) entrepreneurial energy, intellectual capacity, and market potential required to become a continental leader in ICT-driven STEM education and innovation. What is now required is collective resolve, (intentional involvement of female), visionary leadership, and sustained investment.

The transformation of Nigeria's tertiary education system is not merely an educational reform agenda, it is a national development imperative, an economic necessity, and a strategic pathway toward a prosperous, inclusive, innovative, and globally competitive Nigeria.

APPENDICES

Appendix I

Table 1: Responsibility Matrix for the Implementation of the Research Infrastructure and Digital Transformation Component

Strategic Programme	Lead Institution(s)	Supporting Institutions	Key Responsibilities
1. National Research Infrastructure Modernization Programme	Federal Ministry of Education (FME); Tertiary Education Trust Fund (TETFund)	National Universities Commission (NUC); National Board for Technical Education (NBTE); National Commission for Colleges of Education (NCCE); Federal Ministry of Science, Innovation and Technology (FMSTI); State Ministries of Education; Higher Education Institutions (HEIs)	Develop infrastructure standards; mobilize funding; modernize laboratories and workshops; monitor implementation.
2. National Shared Scientific Equipment Programme	TETFund; FMSTI	NUC; NBTE; NCCE; National Research Institutes; HEIs	Establish national equipment inventory; coordinate regional shared facilities; develop access and maintenance policies.
3. Digital Research Ecosystem Programme	FME	NUC; NBTE; NCCE; National Information Technology Development Agency (NITDA); Nigerian Research and Education Network (NgREN); HEIs	Deploy Research Information Management Systems (RIMS); digitize research administration; establish institutional repositories.
4. National Research and Education Network Expansion Programme	Federal Ministry of Communications, Innovation and Digital Economy (FMCIDE); NgREN	Nigerian Communications Commission (NCC); Galaxy Backbone; NITDA; HEIs; Internet Service Providers (ISPs)	Expand broadband infrastructure; connect institutions; improve network resilience and cybersecurity.
5. Emerging Technologies Research Programme	FMSTI	FME; TETFund; NUC; NITDA; National Centre for Artificial Intelligence and Robotics (NCAIR); HEIs; Industry	Establish AI, robotics, IoT, HPC, and advanced manufacturing laboratories; support research in frontier technologies.

6. National Open Science Initiative	FME	NUC; National Library of Nigeria; TETFund; HEIs; Research Institutes	Develop open science policy; establish digital repositories; promote research data sharing and FAIR data principles.
7. Scientific Equipment Management Programme	TETFund	FMSTI; Standards Organisation of Nigeria (SON); HEIs; Equipment Suppliers	Develop equipment lifecycle management systems; strengthen maintenance, calibration, and technical support.
8. Digital Innovation Partnership Programme	FMSTI	Bank of Industry (BOI); Nigerian Sovereign Investment Authority (NSIA); Industry Associations; HEIs; Innovation Hubs	Promote university–industry collaboration; fund joint research projects; strengthen technology transfer.
9. Research Cybersecurity Programme	NITDA	National Information Technology Development Agency Computer Emergency Readiness Team (NITDA-CERT); Office of the National Security Adviser (ONSA); Galaxy Backbone; HEIs	Develop cybersecurity standards; secure research infrastructure; build institutional cyber resilience.
10. National Digital Research Skills Programme	FME	NUC; NBTE; NCCE; TETFund; HEIs; Professional Bodies	Develop curricula; deliver digital skills training for researchers, technicians, and administrators.
11. Innovation and Commercialization Programme	FMSTI	BOI; Nigerian Export Promotion Council (NEPC); TETFund; HEIs; Industry	Strengthen Technology Transfer Offices (TTOs); support incubation, patenting, licensing, and startup creation.
12. Inclusive Research Infrastructure Programme	FME	NUC; NBTE; NCCE; State Governments; TETFund	Ensure equitable distribution of research infrastructure; support underserved institutions and regions.

13. Research Intelligence and Analytics Programme	National Universities Commission (NUC)	FME; NBTE; NCCE; National Bureau of Statistics (NBS); TETFund; HEIs	Develop national research dashboards; collect and analyse performance data; support evidence-based policymaking.
14. Global Research Collaboration Programme	FMSTI; Federal Ministry of Education	Nigerian universities; Research Institutes; International Development Partners; African Union; ECOWAS	Facilitate international research partnerships; coordinate participation in multinational programmes; mobilize external funding.
15. Green Research Infrastructure Programme	Federal Ministry of Environment (FMEv); FMSTI	Rural Electrification Agency (REA); Energy Commission of Nigeria (ECN); TETFund; HEIs	Promote renewable energy, green laboratories, sustainable procurement, and environmentally responsible laboratory practices.

Appendix II

Table 2: Annual Implementation Priorities for Research Infrastructure and Digital Transformation

Year	Priority Actions
2026	Conduct national infrastructure audit; establish governance structures; develop standards and implementation guidelines; initiate digital transformation pilots.
2027	Launch laboratory upgrades; establish shared equipment inventory; begin broadband expansion; introduce digital research management systems in pilot institutions.
2028	Scale up infrastructure investments; establish regional shared research centres; expand NgREN connectivity; launch AI and HPC centres.
2029	Roll out institutional repositories; expand researcher training programmes; strengthen equipment maintenance systems; implement cybersecurity frameworks.
2030	Mid-term review; evaluate programme performance; accelerate commercialization initiatives; strengthen university–industry partnerships.
2031	Expand international collaborations; integrate research data repositories; enhance digital governance and analytics.
2032	Increase research commercialization; strengthen green research infrastructure; deploy advanced digital platforms across all institutions.
2033	Consolidate digital transformation; optimize shared research infrastructure; improve monitoring and performance management.
2034	Institutionalize sustainable financing and maintenance models; expand renewable energy adoption in research facilities.
2035	Final evaluation of the strategy; benchmark Nigeria's research ecosystem internationally; develop the next-generation Research Infrastructure and Digital Transformation Strategy (2036–2045).

Appendix III

Table 3: Implementation Timeline for Research Infrastructure and Digital Transformation

Strategic Programme	Key Activities	Phase I (2026–2027)Foundation	Phase II (2028–2030)Scale-up	Phase III (2031–2033)Expansion	Phase IV (2034–2035)Sustainability
1. National Research Infrastructure Modernization Programme	Infrastructure audit, laboratory modernization, equipment procurement	●	●●●	●●	●
	Construction of Centres of Excellence	●	●●	●●●	●
2. National Shared Scientific Equipment Programme	National equipment inventory	●●	●		
	Establish regional shared facilities	●	●●●	●●	●
	Online equipment booking platform	●	●●	●	●
3. Digital Research Ecosystem Programme	Develop national digital research framework	●●			
	Deploy Research Information Management Systems (RIMS)	●	●●●	●●	●
	Digitize research administration	●	●●●	●●	●
	Institutional digital repositories	●	●●	●●●	●
4. National Research and Education Network (NgREN) Expansion	Broadband infrastructure upgrade	●●	●●●	●●	●
	Connect HEIs to NgREN	●	●●●	●●	●

	Campus Wi-Fi deployment	●	●●	●●●	●
5. Emerging Technologies Research Programme	AI laboratories	●	●●	●●●	●
	HPC facilities	●	●●	●●●	●
	Robotics, IoT, GIS laboratories		●●	●●●	●
6. National Open Science Initiative	Open Science policy	●●			
	Institutional repositories	●	●●	●●●	●
	National research data repository		●●	●●●	●
7. Scientific Equipment Management Programme	Equipment maintenance centres	●	●●	●●	●
	Laboratory technician training	●●	●●●	●●	●
	Calibration programme	●	●●●	●●●	●●
8. Digital Innovation Partnership Programme	University-industry collaboration platform	●	●●	●●●	●●
	Joint digital research projects		●●	●●●	●●
9. Research Cybersecurity Programme	Cybersecurity framework	●●	●		
	Institutional cybersecurity implementation	●	●●●	●●●	●●
	Cybersecurity audits		●●	●●●	●●●
10. National Digital Research Skills Programme	Digital skills curriculum	●●			
	Researcher capacity building	●	●●●	●●●	●●
	Advanced AI/Data Science training		●●	●●●	●●

11. Innovation and Commercialization Programme	Technology Transfer Offices (TTOs)	●	●●	●●●	●●
	Innovation hubs	●	●●	●●●	●●
	Startup incubation		●●	●●●	●●●
12. Inclusive Research Infrastructure Programme	Upgrade underserved institutions	●	●●	●●●	●●
	Regional infrastructure grants	●	●●	●●●	●●
13. Research Intelligence and Analytics Programme	National research dashboard	●	●●	●	●
	Institutional reporting system	●	●●●	●●	●●
	Annual performance reports		●●	●●●	●●●
14. Global Research Collaboration Programme	International partnerships	●	●●	●●●	●●●
	International research grants		●●	●●●	●●●
	Research mobility programmes		●	●●	●●●
15. Green Research Infrastructure Programme	Renewable energy for laboratories	●	●●	●●●	●●
	Green laboratory certification		●	●●	●●●
	Sustainable laboratory waste management	●	●●	●●●	●●●

Legend:

- ● = Initiation
- ●● = Major implementation
- ●●● = Full-scale implementation and consolidation

Appendix IV

In addition to programme-specific indicators, the following national KPIs should be monitored annually:

Table 4: Cross-Cutting KPIs for Innovation, Entrepreneurship and Industry Linkages

Indicator	Measure
Active university–industry partnership agreements	Number per institution and nationally
Industry-funded research	Value (₦) and percentage of total research funding
Innovation hubs and incubators	Number established and operational
Startups created from higher education institutions	Number per year
Startups surviving beyond three years	Percentage
Patents filed and granted	Number annually
Technologies commercialized	Number of products/processes licensed or deployed
Licensing and commercialization revenue	Annual income (₦)
Graduate entrepreneurship rate	Percentage of graduates establishing enterprises
Graduate employment in STEM sectors	Percentage employed within 12 months of graduation
Students completing entrepreneurship training	Percentage of STEM students
Faculty participating in industry collaboration	Percentage of academic staff
Venture capital and private investment mobilized	Annual value (₦)
Women-led and youth-led innovation enterprises	Number and percentage
International innovation partnerships	Number of active collaborations
Higher education institutions with Technology Transfer Offices	Percentage nationally
Institutions with functional innovation policies	Percentage nationally
National ranking in the Global Innovation Index	Improvement in rank over time
Contribution of university innovations to industrial production	Number of technologies adopted by industry

Appendix V

Annual Performance Contract
for the STEM ICT-Driven Tertiary Education Transformation Strategy
Between the Federal Ministry of Education / National Universities Commission and the Institution named below

1. Parties and Contract Period

Institution Name: _____

Institution Type: _____ **NUC Reference No.:** _____

Contract Period: _____

Vice-Chancellor / Rector / Provost: _____ **Date Signed:** _____

Signing Government Agency / Representative: _____

2. Annual STEM Transformation Targets & KPIs

List each institutional target for the contract year, its associated Key Performance Indicator, current baseline, and the year-end target to be achieved.

Target / Deliverable	KPI (Measure)	Baseline	Year-End Target

3. Institutional Deliverables

Specify the concrete, verifiable deliverables the institution commits to producing during the contract period (e.g. functional laboratories, revised curricula, signed industry MoUs, certified faculty).

Deliverable 1: _____

Deliverable 2: _____

Deliverable 3: _____

Deliverable 4: _____

4. Funding Commitments

Detail the funding to be disbursed by government/partner agencies against this contract, any institutional co-funding obligation, and the conditions under which funds will be released.

Funding Line Item	Government Commitment (₦)	Institutional Co-Funding (₦)	Disbursement Trigger

5. Reporting Timelines

The institution shall submit the following reports within the stated deadlines to the designated agency.

Report Type	Submission Deadline	Recipient Agency
Quarterly Progress Report		NUC / FME
Mid-Year Financial Report		NUC / TETFund
Annual Performance Report		NUC / FME
EMIS Data Upload		NUC / National EMIS

6. Risk Mitigation Strategies

Identify anticipated implementation risks specific to this institution and the measures in place to mitigate them.

Identified Risk	Likelihood	Impact	Mitigation Measure

7. Expected Student, Research, and Innovation Outcomes

State the outcome-level results this institution is accountable for beyond its immediate deliverables.

Outcome Domain	Indicator	Expected Result
Student Outcomes		
Research Outcomes		
Innovation / Entrepreneurship Outcomes		
Gender Equity Outcomes		

8. Incentives and Accountability

In accordance with Section 10.2.5 of the STEM ICT-Driven Transformation Strategy, satisfactory performance under this contract may result in competitive intervention grants, additional infrastructure support, research funding incentives, or national recognition. Persistent underperformance may result in a corrective action plan, technical support intervention, or enhanced oversight and compliance review.

9. Declaration and Signatures

By signing below, both parties confirm agreement to the targets, deliverables, funding terms, and accountability mechanisms set out in this Annual Performance Contract.

For the Institution:

Name: _____ **Signature:** _____

Title: _____ **Date:** _____

For the Government Agency:

Name: _____ **Signature:** _____

Title: _____ **Date:** _____

NATIONAL UNIVERSITIES COMMISSION

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STEM Transformation Strategy Document for Higher Education in Nigeria (2026–2036)

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