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SUMMARY REPORT

What is the status of Science and Technology Awareness (STA) in Early Childhood Care and Education (ECCE) curricula in West and Central Africa?

A CRITICAL ANALYSIS OF THE STATUS OF SCIENCE AND TECHNOLOGY AWARENESS IN EARLY CHILDHOOD EDUCATION (ECCE) CURRICULA IN WEST AND CENTRAL AFRICA

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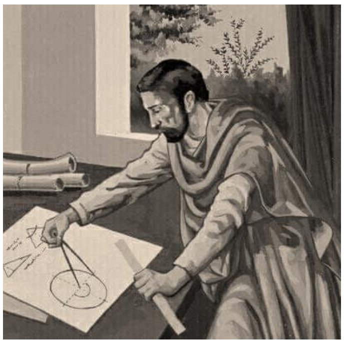

"Joy is looking and comprehending is nature's most beautiful gift." - Albert Einstein. Looking and comprehending is the GOAL of science and technology awareness for young children.

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1. ACKNOWLEDGEMENTS

The critical analysis described in this report was conducted in the context of the World Conference on Early Childhood Care and Education and the implementation of the intergovernmental Tashkent Declaration (adopted in November 2022), which is underpinned by one of the four pillars of the curriculum and pedagogy for quality education.

The report is the result of a productive collaboration between the UNESCO International Bureau of Education (UNESCO-IBE) and the experts Ms. Raïssa Malu, International Consultant on Education and promoter of the Science and Technology Week in the Democratic Republic of the Congo, and Ms. Dora Kebadio-Muanda, Science teacher and Scientific Director of the Science and Technology Week in the Democratic Republic of the Congo. Their scientific and pedagogical expertise in the area of science as well as their passion for promoting science, technology, engineering, and mathematics were invaluable in the preparation of this report on the critical analysis. We would like to extend our most sincere gratitude to them for their important contributions that were relevant, enlightening, and innovative.

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At last but not least, many thanks to Alexandra Draggeim for the English translation of this analysis report.

2. INTRODUCTION

As part of the implementation of the Recommendations of the *United Nations Transforming Education Summit* (September 2022), of its renewed mandate, and its Medium-Term Strategy 2022-2025, the International Bureau of Education of UNESCO (UNESCO-IBE) is providing technical support to Member-states to improve education quality and transform education. In the face of multiple challenges and constant change, today's world needs education that accounts for, anticipates, and adapts to these changes. **Countries must transform their education systems to enhance their resilience and relevance, while promoting the skills of the 21st century, and the abilities, values, and attitudes that citizens need.**

Education can only be transformed if curricula are transformed. This is why learners must urgently be equipped with the necessary knowledge, skills, values, and attitudes so that they are resilient, adaptable, and prepared for an uncertain future, while working for the sake of society, the planet and sustainable development. The Declaration of the African Union (AU) on transforming education in Africa (2023) lays the groundwork for this commitment by selecting Education as the African Union (AU) Theme for 2024. To accelerate progress on the Sustainable Development Goals (SDGs) and especially SDG 4.2, one of the twelve commitments of the African Union is to focus on basic learning from a young age with an emphasis on STEM education in line with the goals and priority areas of Agenda 2063 and the Continental Education Strategy for Africa (CESA).

Today, however, the African continent is experiencing a shortage of scientists and accounts for only 2% of world research output, even though this is one of the key levers for promoting sustainable economic growth and long-term social progress on the continent. Today, 49% of students under the age of 14 are studying STEM using dry, outdated methods, mainly by reading textbooks in class and committing scientific concepts to memory. Nonetheless, the COVID-19 pandemic underscored the importance of scientific literacy in the population as a whole and among political decisionmakers, forcing us to put science back at the centre of our daily lives. During the COVID-19 pandemic, countries relied more heavily on the scientific community for advice and practical solutions. **To achieve its medium and long-term development goals, Africa needs scientists and scientific literacy now more than ever. We must urgently allow learners to become agents for change from a young age by obtaining the knowledge, skills, values, and attitudes that will help transform our societies.**

Curious by nature, young children love exploring the world around them and eagerly participate in building and engineering activities, research and problem solving, learning through trial and error, cognitive reasoning, and sequencing. **Linked with other levels of education in an appropriate and relevant manner, Early Childhood Care and Education (ECCE) creates an excellent window of opportunity for nurturing and boosting learners' curiosity, encouraging them to display interest in their environment and how nature works, while fostering a love and enjoyment of science and building a strong foundation in scientific concepts and the scientific method.** When these emerging and fundamental skills are acquired, they can be broadly reused, progressively integrated, and coordinated through the study of various areas of scientific learning throughout learners' education.

Based on a preliminary document review, this critical analysis report provides an overview of the area of learning related to Science and Technology Awareness (STA) in ECCE curricula in 18 countries in West and Central Africa. It aims to galvanize systems of knowledge production and to support country reflection and action by clarifying and demystifying the process of teaching and learning about science while promoting values and attitudes to highlight a science-based approach from a young age. The goal is **to create an environment favourable to the development of science and technology and realise the potential of every learner, to encourage** budding scientists, and to increase scientific literacy.

3. THEORETICAL FRAMEWORK

A. CONTEXT AND JUSTIFICATION

The Transforming Education Summit took place in New York in September 2022 under the theme of "Transforming Education, Building our Future" with the goal of mobilising global leaders to take concrete measures to promote education and lifelong learning. A high-level side event[1] was held on the sidelines of the Summit with the participation of heads of state and government of the African Union (AU), which culminated in the **Declaration on Transforming Education in Africa**. Recalling Aspiration 6 of the AU Agenda 2063[2], the heads of state and government of the African Union committed to: 1) "**allocating additional funds** to neglected but essential subsectors with a high return on investment, such as **early childhood care and education**;" 2) "focusing on basic learning from a young age to raise the level of learning by **emphasizing Science, Technology, Engineering and Mathematics (STEM) education** and basic reading in nursery schools and primary schools."

Shortly thereafter, in November 2022, ministers, heads and members of delegations, representatives of United Nations agencies, development cooperation agencies, civil society organisations, educators, and experts met in Tashkent, Uzbekistan, on the invitation of the UNESCO Director General, for the World Conference on Early Childhood Care and Education. In the resulting **Tashkent Declaration** the participants adopted "**guiding principles and strategies for the urgent transformation of ECCE**, including to: 1) "improve the relevance and quality of **ECCE curricula and pedagogy**"; 2) "establish relevant **ECCE monitoring and evaluation systems;** 3) "improve the **transitions** within ECCE and into primary education"; 4) "strengthen the education and training systems of **ECCE personnel** with curricula and pedagogies that are responsive to "**global challenges** like climate change, conflict and crises"; 5) "harness **scientific data** for innovating and transforming ECCE policies and practices." Specifically, Member States decided to "engage with the international community to harness scientific evidence and digital technologies to further transform curricula and pedagogy and **to develop the skills children need in a rapidly changing and increasingly digitalised world** in the absence of adequate progress on sustainable development."

As for the development of science and technology, according to various reports, including the 2020 UNESCO Science Report, the African continent is experiencing a shortage of scientists and contributes just 2% of world research output. Yet this is viewed as a key lever for promoting sustainable economic growth and long-term social progress on the continent. In a post-COVID 19 world, where the relationship between science, society, politics, and politicians has been complex and sometimes contested, scientific literacy, as well as the acquisition of scientific or technical knowledge, or "science literacy," remain key. But how can these levers be activated when these fields are still taught using outdated methods and remain unappealing, especially for girls?

B. GOALS AND METHODOLOGY

The goal of this report **is to conduct a critical analysis of the status of science and technology - in terms of both content and pedagogical approach - in existing Early Childhood Care and Education (ECCE) curricula in West and Central Africa.** It is an important first step on the path towards developing a methodological guide that would equip Member States with the conceptual guidelines and practical tools they need for the development of ECCE curricula related to science and technology awareness to ensure a quality early childhood education.

[1] *Held on Tuesday, September 20, 2022, under the theme "Transforming Education in Africa: Past, Present and Future."*

[2] *Aspiration 6 of the AU Agenda 2063 sees "an Africa, whose development is people-driven, relying on the potential of African people, especially its women and youth" and "ensuring that Africa's youth will enjoy full access to education, training, skills, and technology."*

The goals of the study are as follows:

1) Through a documentary review of current ECCE curricula of 18 countries in West and Central Africa, to list and codify explicit and/or implicit content related to Science and Technology Awareness (STA) as well as items related to teaching/learning, pedagogy, suggested tools/materials, teacher/educator training on the subject, etc.

2) To analyse Science and Technology Awareness (STA) with respect to the goals achieved, the typology of proposed activities, challenges, and perspectives, while highlighting areas of convergence and divergence and identifying strengths, weaknesses, opportunities, and threats.

3) To propose general recommendations that would promote a more efficient and relevant implementation of Science and Technology Awareness (STA) in curricula, including by identifying priority areas for intervention and for strategic and operational perspectives as a critical starting point for the creation of a methodological guide.

The methodological approach consisted of reading and analysing existing and available curricula, as well as pedagogical and activity guides, and identifying the relevant criteria for a summary analysis based on the guiding principles and strategies of the Tashkent Declaration.

The geographic scope of the report was expected to include 25 countries in West and Central Africa. 18 countries were eventually included, due to the non-availability or revision in progress of ECCE curricula in the other countries. **The following 18 countries were examined: Angola, Benin, Burkina-Faso, Cameroon, Cabo Verde, Chad, Côte d'Ivoire, Democratic Republic of Congo, The Gambia, Ghana, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.**

The following **criteria** were used for the analysis: the **relevant age range** to create a link with overall child development; the **purposes of ECCE** to evaluate its design/incorporation into the educational system, especially basic education; **pedagogy**, comparing methods used in primary and secondary education; the **science-related area of learning** to measure the importance of STA in the curriculum more broadly; the **purposes of STA** to identify how it is defined; the **teacher profile** to evaluate the expected level of professionalism broadly and/or specifically with respect to this area of learning; **STA activities** to measure their relevance, coherence and completeness; **teaching materials** to evaluate their availability/accessibility and diversity; and **evaluation tools** to measure the effectiveness of the educational process. A summary diagram is pictured below *(see Figure 1 - Criteria for analysing curricula).* Other items such as the title of the curriculum, the supervisory authority, and the curriculum year of publication rounded out the list of criteria to create a better understanding of the general context.

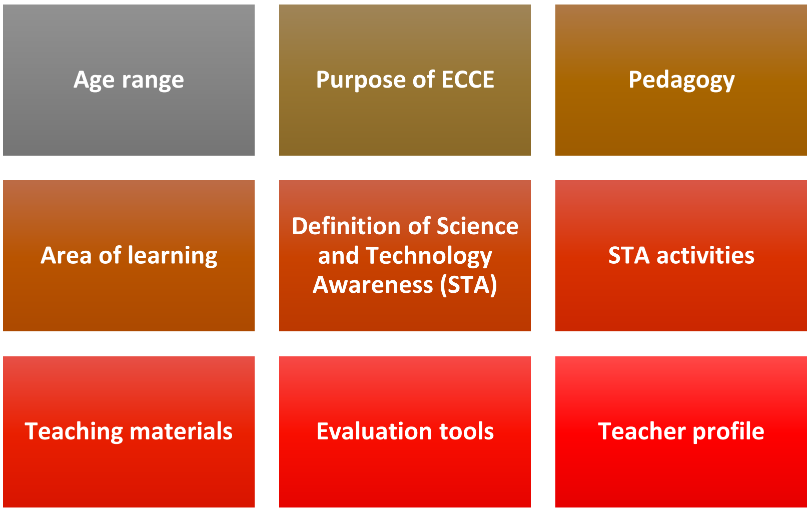

Diagram 1 - Criteria for analysing curricula

All of these criteria were then included in a **summary table** with examples of **promising practices** from the analysed curricula.

After presenting arguments based on research and backed up by practice, the analysis also includes data from scientific works, such as on the **categorisation of Science and Technology Awareness activities** (Chauvet-Chanoine, 2009) into the following five types:

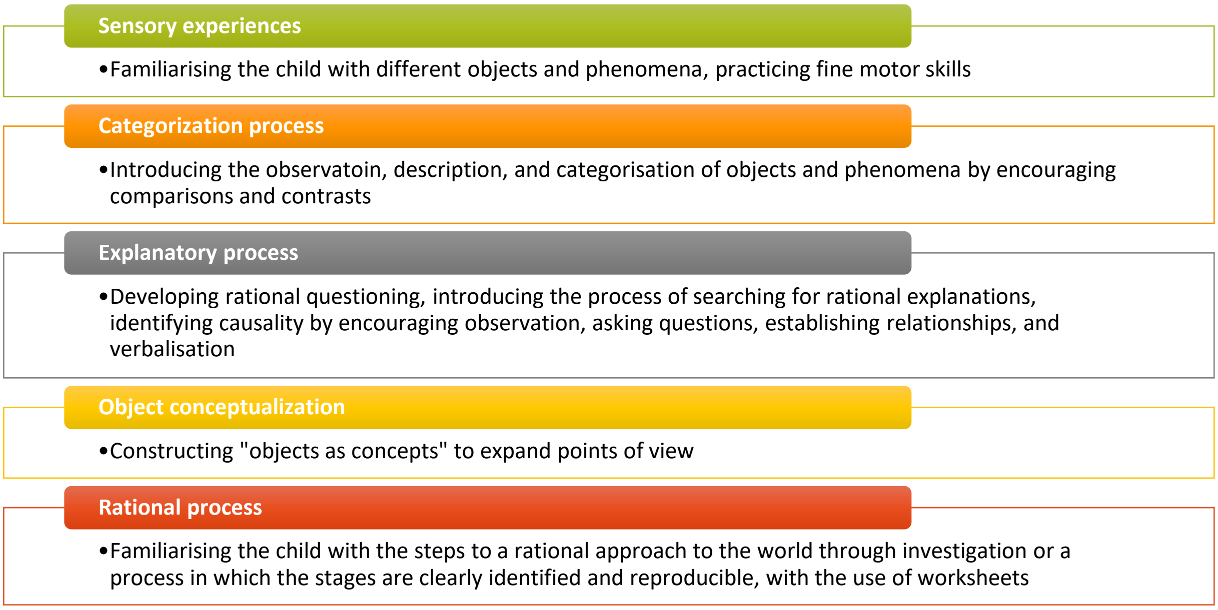

Figure 2 - The categorisation of science and technology awareness-raising activities based on Chauvet Chanoine 2019

The country comparison was not conducted in a strictly binary sense for most of the criteria. The main goal was to capture nuance or highlights that would help compare different countries. This is also the approach used to identify promising practices listed in the summary table.

Finally, although conceptually mathematics is part of science, this domain of learning is generally viewed as a stand-alone domain in ECCE curricula and separate from Science and Technology Awareness (STA). Although it is an indispensable tool for modelling and solving problems, the specific area of learning of mathematics in ECCE (emergent mathematics) was not explicitly considered in this report's analysis. Nonetheless, it is important to note that opportunities for integrated learning do exist, when children are led to simultaneously explore and develop their skills in mathematics, science, and technology. By combining these areas of learning, children can be encouraged to forge links between concepts and to develop a comprehensive understanding of how the world works.

C. CONCEPTUALIZING KEY CONCEPTS

This section contains definitions of several key concepts related to the integration of Science and Technology Awareness (STA) into ECCE curricula in alphabetical order. Although the definitions are not exhaustive, the aim is to propose and/or clarify a conceptual framework of fundamental principles within which this critical analysis is conducted. This conceptualization expands the opportunities available when it comes to Science and Technology Awareness and promotes reflection on the gap between the current situation and what is possible.

21ST CENTURY SKILLS

Everyone needs 21st century skills to succeed in today's complex, changing world dominated by technology created during the Fourth Industrial Revolution, including artificial intelligence (AI). People must possess a broad range of skills, on some of which there is broad agreement: collaboration, communication, cultural and social skills, citizenship, as well as information, media, and technology literacy. There are also additional skills included in most benchmarks: creativity and innovation, critical thinking and problem solving. Finally, other cross-cutting life skills, which involve knowledge, skills, and attitudes are increasingly in demand: empathy, planning, flexibility, independence, and initiative.

SCIENTIFIC AND TECHNOLOGICAL LITERACY

Scientific and technological literacy can be defined as the ways and means by which a society appropriates science and technology. It helps prepare citizens to understand the world around them, to act on it and to take on social and global challenges.

OBJECT CONCEPTUALIZATION

The process of "object conceptualization" refers to prompting children to build concepts based on specific objects by expanding their points of view (Chauvet-Chanoine, 2009). Below is a suggested activity that illustrates the process.

Activity: Exploring measures with standards[3]

Standards can play an important role in object conceptualization by helping children create concepts based on the specific objects they encounter. By using standards for specific activities, children can explore concepts such as measurement, comparison, classification, and generalization. They can also develop their logical thinking, observation skills, and their understanding of relationships between objects. Standards can be a concrete starting

[3] *A reference standard, often called a "standard," may also be equivalent to an amount not known very precisely, but which serves as a reference to express the value of the same kind of quantities.*

point for children, helping them create abstract concepts and increase their understanding of the world that surrounds them.

Here is how standards can help:

1. Comparison and classification: Standards allow children to compare object characteristics and to describe them based on their similarities and differences. For example, by using standards of different sizes, children can observe and compare the length or size of objects, developing their classification skills.

2. Creating references: Standards serve as measurement references for children. By using standards of a particular length or size, they can create references for assessing other objects. This helps them create references and understand scale relationships between objects.

3. Abstraction and generalization: Standards help children to develop their abstraction and generalization skills. By using standards to measure different objects, children can understand that general measurements can be taken of similar objects, even if they have a different shape or appearance.

4. Language development: Standards promote language development in children by giving them something to compare with. By using the standards, children can learn to use words such as “longer,” “shorter,” “same length,” etc., to describe objects and the relationships between them.

THE SCIENTIFIC METHOD

The scientific method is a rigorous, systematic approach that leads to the production of scientific knowledge. It consists of multiple steps: making an observation, forming a hypothesis, testing the hypothesis with an experiment or observations, analysing the data, drawing a conclusion, and communicating the results. It allows for the production of reliable, reproducible knowledge.

THE HOLISTIC DEVELOPMENT OF CHILDREN

The holistic development of children means supporting them in every interconnected dimension (physical, cognitive, social, linguistic, and social-emotional) and promoting an inclusive, quality education that puts learners’ needs first. Recent neuroscience research shows that early childhood is a period of exponential brain growth, when new fundamental neural connections and networks - known as brain plasticity – are created, promoting children’s academic success. This capacity of young children’s brain is the foundation for the development of more complex abilities based on the integration of skills, knowledge and basic abilities that emerge from the child’s discoveries and exploration. These are not acquired simultaneously, and the order varies from one child to the next. The learning process in young children is progressive, unique to each child, and evolves over time. Teachers and educators need to be able to identify the Zone of Proximal Development (ZPD) (the space between what a learner can do and their potential) to support and sustain the learning process.

The development of executive functions and social skills creates a set of key cognitive and metacognitive skills that helps individuals to plan, organise and regulate their behaviour, to solve problems and take decisions, and also promotes empathy for others, social interaction (asking questions, setting goals, deciding how they can be achieved through working together), and the ability to adapt to changes in the environment. Executive functions and social cognition lie at the very heart of Science and Technology Awareness (STA).

SCIENCE AND TECHNOLOGY AWARENESS (STA)

Science awareness brings together a pool of resources (knowledge, skills, attitudes, abilities, etc.) to be mastered, mobilised, and used to describe, understand, and explain the natural and physical world. It refers to an open attitude and a state of mind that should also encourage reflection on ethics and the moral implications of our actions and innovations and the development of a critical attitude towards any possible violations.

Technology awareness is when a person or a society realizes the importance of technology in our daily lives. This awareness depends on factors such as age, education, history, and the environment.

Here are some examples of science and technology awareness activities:

- *Discovering the natural world:* Activities to explore animals, plants, natural habitats, the life cycle of organisms, the seasons, the weather, and natural phenomena such as rain, wind, etc.
- *Scientific experiments:* Activities that encourage children to ask questions, form a hypothesis, conduct simple experiments, and observe and record their data, fostering their curiosity and scientific spirit.
- *Technology and innovation:* Activities that introduce children to basic technological concepts, for example by using simple tools, building simple structures, understanding simple machines, and exploring technological innovations in our daily lives.
- *Problem solving:* Activities that promote critical thinking, problem solving, and the development of logical reasoning through construction games, puzzles, brainteasers, and sorting and classification activities.

SCIENTIFIC MEDIATION

Scientific mediation refers to all activities and processes that promote the transfer of scientific and technological knowledge to the public. Its goal is to make science accessible, understandable, and relevant for a broad range of people by encouraging their engagement, curiosity, and critical thinking. It can take on various forms, such as interactive exhibits in museums, conferences, practical workshops, science shows, public events, the media, online educational resources, debates, demonstrations, etc. Its goal is to bridge the gap between scientists and the public by promoting communication and the exchange of information.

Scientific mediation has multiple goals:

1. *Popularisation:* Scientific mediation helps make complex scientific concepts more accessible by explaining them clearly, concisely, and in a way that is adapted to the target audience. It relies on specific examples, analogies, and visual aids to support understanding.

2. *Outreach:* Fosters interest and curiosity for science among the public by highlighting the important role of science in society, its impact on our daily lives, and how it can help with problem solving.

3. *Education:* Scientific mediation is also meant to achieve an educational goal by providing accurate, up-to-date information about scientific advances, methods and research, recent discoveries, and modern scientific challenges.

4. *Commitment:* Encourages the public to actively participate in learning about science by promoting interaction, working with objects, experiments, debates, and the exchange of ideas.

5. *Ethics:* Scientific mediation also addresses ethical issues in science and technology by encouraging reflection on the social, environmental, and ethical implications of scientific advances.

The skills necessary for scientific mediation include a solid understanding of scientific concepts, the ability to communicate clearly while tailoring your message to different audiences, pedagogical skills to design interactive activities, and facilitation skills to engage and captivate the audience. Scientific mediation is a dynamic and interactive process that aims to bring science closer to the public by facilitating the public's understanding, interest, and involvement in scientific and technological issues.

SCIENCE

Science is the body of knowledge about a particular topic. This term can also refer to a community, scientists, and researchers who are working on a specific subject, as well as to technological applications, outputs, and consequences, and the scientific method – the methodology used to establish knowledge. Science is divided into fields, sciences, or scientific areas that fall under one of two branches, *the formal sciences* or *the empirical sciences.* The formal sciences are the study of abstract objects such as numbers, geometric figures, and logical symbols (mathematics, computer science, and logic). The empirical sciences are the study of specific objects such as nature, people, or society. Empirical sciences include the *natural sciences* (life and environmental science, science of the earth and the universe, the science of matter) as well as the human and social sciences.

THE BIOLOGICAL SCIENCES

The biological sciences, also known as biology, are a branch of natural science that concern themselves with the study of living organisms, their structure, function, evolution, and interaction with their environment. Biology explores a vast variety of levels of organisation, from molecules and individual cells to ecosystems and the entire biosphere.

Below are some of the **areas** associated with biological science along with their characteristics:

1. *Cell biology:* Cell biology focuses on the study of the cell, the basic unit of life. It explores cell structure, functions, reproductive mechanism, organelles, and cellular processes such as cell division, cell signalling, and cellular metabolism. Cell biology is key to understanding basic biological processes and the physiology of organisms.

2. *Genetics:* Genetics is the study of heredity and genetic variation in living organisms. It investigates structure, function, the transmission of genetic information, gene expression, genetic mutation, population genetics, and methods for genetic manipulation such as genetic engineering. Genetics is key to understanding genetic disorders, evolution, and biodiversity.

3. *Molecular biology:* Molecular biology is the study of biological processes at the molecular level, with a focus on interaction between molecules such as DNA and RNA, proteins, and enzymes. It explores the structure, function, and regulation of biological molecules, as well as the molecular mechanisms underlying reproduction, growth, development, and disease.

4. *Physiology:* Physiology is the study of the functions and processes in living organisms. It studies how organic systems interact to maintain an equilibrium and ensure survival. Physiology is divided into subdisciplines such as human physiology, plant physiology, animal physiology, and comparative physiology. Physiology deals with examining aspects such as respiration, digestion, circulation, the nervous system, hormones, and metabolism.

5. *Ecology:* Ecology is the study of how living things interact with their environment. Ecologists study the relationships between organisms and abiotic factors (such as climate, soil, and light), interactions

between organisms of one species (population ecology) and across species (community ecology). They also address subjects such as biogeography, biodiversity conservation, and ecosystem ecology.

The **skills** required in the biological sciences include:

- A deeper understanding of the basic concepts of biology, such as cell structure, DNA, genes, and the mechanisms of evolution.
- The ability to conduct experiments in the laboratory, to collect and analyse biological data, and to use the appropriate instrumentation techniques.
- Skills related to observing, identifying, and classifying living organisms.
- Mastery of the skills necessary for genetic analysis, cell culture, microscopy, and the manipulation of biological data.
- Problem solving, logical reasoning, and critical thinking skills to be able to analyse and interpret experimental data.
- Knowledge of security protocols and best practices for biology laboratories.

THE CHEMICAL SCIENCES

The chemical sciences, commonly known as "chemistry," are a branch of natural science that deals with the study of the composition, structure, properties, and transformation of matter. Chemists concern themselves with atoms, molecules, chemical reactions, and the interactions between different substances. Chemistry plays a central role in many scientific and technological fields. In the International Standard Classification of Education (ISCED), which is the reference international classification for organising education systems, chemistry is part of the physical sciences.

Below are some of the **areas** associated with chemistry along with their characteristics:

1. *Organic chemistry:* Organic chemistry is the study of the structure, properties, composition, and reactions of carbon-containing compounds. It explores compounds such as hydrocarbons, alcohols, carboxylic acids, amines, polymers, and biological compounds. Organic chemistry is key in areas such as drug synthesis, materials chemistry, and food chemistry.

2. *Inorganic chemistry:* Inorganic chemistry is the study of inorganic, i.e. not carbon-containing, compounds, such as salts, oxides, acids, basis, and metal complexes. It deals with the properties and reactions of elements and inorganic compounds, as well as their use in various fields, such as catalysis, electrochemistry, and materials chemistry.

3. *Analytical chemistry:* Analytical chemistry encompasses the methods and techniques used to determine the composition, structure, and properties of a substance. It can be divided into qualitative analytical chemistry, which identifies the components and types of chemicals present in a sample, and quantitative analytical chemistry, which measures the quantities of substances present. In this field, chemical analysis, instrumentation, and data interpretation skills are indispensable.

4. *Physical chemistry:* Physical chemistry combines the principles of chemistry and physics to study the theoretical and experimental aspects of chemical phenomena. It deals with the physical properties of molecules, chemical reactions, chemical kinetics, chemical equilibrium, chemical thermodynamics, and spectroscopy. Mathematics, modelling, and data analysis skills are important in physical chemistry.

5. *Theoretical and computational chemistry:* This field uses modelling and computing tools to study and predict the properties and behaviours of chemical systems. It relies on the methods of quantum

mechanics, molecular dynamics, and digital simulations to understand molecular structures, chemical reactions, and the electronic and thermodynamic properties of substances.

The skills required in the *chemical sciences* include:

- A solid understanding of the basic principles of chemistry, including atomic structure, chemical bonds, chemical reactions, and the laws of thermodynamics.
- The ability to safely conduct chemical experiments, manipulate chemical substances and use laboratory techniques.
- Mastery of chemical analysis methods and instruments used in chemistry, for example in spectroscopy, chromatography, and mass spectrometry.
- Problem solving, logical reasoning, and critical thinking skills to be able to analyse data and interpret experimental results.
- Knowledge of safety rules and ethical practices for laboratory work.

THE PHYSICAL SCIENCES

Physical sciences, also called the "sciences of nature" or "the physical and natural sciences," are a branch of science that deals with the study of nature and the behaviour of matter and energy. Physical sciences rely on observation, experimentation, modelling, and the formulation of mathematical laws and theories to describe all physical phenomena.

The following are the main **areas** of physical sciences:

1. *Mechanics:* Mechanics is the study of motion and equilibrium of objects and the forces that act upon them. It includes subjects such as kinematics (the study of motion without reference to the causes of motion), dynamics (the study of the causes of motion) and fluid mechanics.

2. *Thermodynamics:* Thermodynamics addresses phenomena related to heat, energy, and heat transfer. It deals with the laws governing heat systems, such as engines, refrigerators, and chemical reactions.

3. *Optics:* Optics deals with the study of light and its properties, including reflection, refraction, diffraction, and interference. It includes fields such as geometrical optics (in which light is described in terms of rays) and wave optics (which considers the wave characteristics of light).

4. *Electromagnetism:* Electromagnetism deals with the interactions between electric charge and electric and magnetic fields. It includes subjects such as electrostatics, electrodynamics, electrical circuits, electromagnetic phenomena, and electromagnetic waves (including light).

5. *Nuclear and particle physics:* These areas focus on the study of atomic nuclei, subatomic particles, and their interactions. They deal with subjects such as radioactivity, nuclear reactions, elementary particle physics and the Standard Model of particle physics.

6. *Astrophysics:* This branch of physics deals with the study of physical properties and phenomena that occur in the universe by relying on the basic principles of physics to understand the nature of heavenly bodies, galaxies, and cosmic structures. It is interested mainly in celestial objects such as stars, planets, galaxies, star clusters, nebulae, and black holes.

The **skills** generally required in the physical sciences include:

- A solid understanding of mathematics, specifically algebra, differential and integral calculus, and differential equations.

- The ability to observe, measure and analyse physical phenomena accurately and rigorously.
- A capacity to design and conduct experiments, collect and interpret data.
- Mastery of theoretical concepts and mathematical models used to describe physical phenomena.
- Problem solving, critical thinking and logical reasoning skills.
- A capacity to effectively communicate research results and complex physical concepts to a diverse audience.

EARTH AND LIFE SCIENCES

Earth and life sciences (ELS), also called biological and geological sciences, are a multidisciplinary area that deals with the study of processes and phenomena related to life on Earth, as well as the structure, history, and dynamics of our planet. They encompass biology, geology, ecology, palaeontology, and other related fields.

Below are some of the **areas** associated with the earth and life sciences along with their characteristics:

1. *Biology:* Biology, as mentioned above, deals with the study of living organisms, their structure, function, evolution, and interaction with their environment. It includes fields such as cell biology, genetics, molecular biology, physiology, ecology, and many others. Biology provides a deeper understanding of living organisms, their diversity and role in ecosystems.

2. *Geology:* Geology is concerned with the study of the Earth, its structure, composition, history, and dynamic processes. Geologists explore rock formations, lithospheric movements, plate tectonics, landform erosion and formation, the formation of minerals and natural resources, as well as the geological history of our planet. Geology is key to understanding Earth's evolution and how it shaped living conditions.

3. *Palaeontology:* Palaeontology is the study of fossils and traces of life of the past, including animals, plants, and microorganisms. Palaeontologists investigate the evolution of species over time, the extinction process, interactions between ancient organisms and their environment, and the reconstruction of ancient ecosystems. Palaeontology plays a key role in our understanding of the history of life on Earth.

4. *Ecology:* Ecology, as mentioned earlier, is the study of the interaction between living organisms and their environment. Ecologists investigate the relationship between organisms and their abiotic factors such as climate, water, and light. They are also interested in the interaction between organisms of the same species (population ecology) and across species (community ecology), as well as in the flow of energy and matter within ecosystems.

The **skills** required in the earth and life sciences include:

- A solid understanding of the basic concepts and principles of biology and geology such as evolution, genetics, plate tectonics, photosynthesis, geological processes, etc.
- The ability to make observations, and conduct experiments and field research to collect biological and geological data.
- The ability to identify and classify living organisms, rocks, minerals, and fossils.
- Mastery of data analysis, modelling, and mapping techniques in the earth and life sciences.
- An understanding of the methods of scientific research, problem solving and logical reasoning, as applied to these fields.
- Science communication skills to present and interpret research results clearly and accurately.

TECHNOLOGY

"Technology" refers to all knowledge, tools, methods, and processes used to solve practical problems, improve activities, or satisfy human needs. Technology is often based on scientific principles and can be applied in different areas.

Below are some of the **areas** associated with technology along with their characteristics:

1. *Engineering technology:* Engineering technology covers a wide range of areas such as civil engineering, mechanical engineering, electrical engineering, chemical engineering, computer engineering, etc. This technology involves the design, construction, manufacturing and improvement of structures, machines, systems, and processes. Each engineering field requires specific technical skills, as well as problem solving, design and project management skills.

2. *Medical technology:* Medical technology includes the mechanisms, equipment and procedures used in the healthcare and medical field for diagnostics, treatment, and disease management. This includes medical imaging equipment such as scanners and MRIs, patient monitoring devices, surgical instruments, implants, prostheses, drugs, and innovative therapies. The necessary skills include a deep understanding of human physiology, technical skills in the use of medical devices, as well as medical research and development skills.

3. *Energy and environmental technology:* This technology focuses on energy production, conversion, and use, as well as on sustainable approaches to environmental conservation. This includes renewable sources of energy (sun, wind, hydro, etc.), energy storage technologies, energy management systems, emission reduction technologies, water treatment systems, waste management technologies, etc. The necessary skills include an understanding of energy and environmental principles, as well as technical skills specific to each technology.

4. *Transportation and mobility technology:* This technology encompasses systems and vehicles used for transporting goods and people. These include motor vehicles, airplanes, trains, ships, navigation systems, traffic control systems, transportation infrastructure, etc. Required skills include knowledge of mechanics, electronics, transportation engineering, logistics management, as well as skills in the design and optimization of transportation systems.

5. Information and communication technologies (ICT): ICTs cover technologies used in communication, transmitting information and data management. This includes computers, computer networks, the Internet, software, mobile applications, data storage and retrieval systems, as well as emerging technologies such as artificial intelligence and machine learning. Programming, network management, software development and data analysis skills are indispensable in this field.

The **skills** required in technology depend on the specific area, but some needed *general skills* include:

- A deep understanding of the underlying scientific and technological principles.
- Technical skills for the use and manipulation of the tools, equipment, and software specific to each field.
- Problem solving, critical thinking and creative skills to offer innovative solutions.
- Communication and collaboration skills to enable teamwork and to effectively convey technological ideas and concepts.
- The ability to learn continuously and to adapt to rapid advances in technology.

4. A COMPARATIVE ANALYSIS OF CURRICULA

A. GENERAL ANALYSIS

This analysis involves 18 countries for which curricula were available. The criteria used are described in the methodology section.

DATE OF LATEST EDITION

Most curricula were published between 2018 and 2023. The oldest curriculum is that of Benin from 2009. The newest one is the Senegal curriculum from 2023. Documents from Côte d'Ivoire, Niger, Nigeria, and Togo did not specify a publishing date.

AGE RANGE

Documents from Burkina Faso, Côte d'Ivoire and Togo provided no details concerning the age range. The country with the biggest age range is Sierra Leone: from 0-8 years of age. Most curricula cover children from the ages of 3-6 in three sections: Petite, Moyenne, and Grande. Besides The Gambia and Togo, all curricula state that classroom activities must be adapted to the overall stage of the children's development, but without providing details on these stages. Mali discusses the psychological development of the child. Nigeria is the only country to explicitly define the development of the child and to describe the cognitive expectations of children by age group.

THE PURPOSE OF ECCE IN THE EDUCATIONAL SYSTEM

All the curricula describe the children's desired profiles by the end of nursery school, but they often do not explicitly describe the transition to the first cycle of primary education. One country with a curriculum where this link is explicit is Cabo Verde, which states that it developed the nursery school curriculum with a view to ensure a smooth transition to primary school. Guinea-Bissau states that it is concerned with the transition to compulsory education. Liberia and Niger specify that they take the goals of primary education into consideration in their ECCE curriculum. Without directly linking the design of the ECCE curriculum to primary education, Angola and Burkina Faso describe the general structure of their respective education systems from preschool to higher education. The Democratic Republic of Congo has set the most formal goal, specifying that their curriculum aims to lay the educational foundation for the development of children's learning to prepare them for access to and successful growth in primary school.

PEDAGOGY AND CONTENT

All ECCE curricula recommend incorporating play into the teaching strategy. Nonetheless, while some countries emphasize play (Angola, Cabo Verde, The Gambia, Guinea-Bissau, Liberia, Nigeria, Chad) as a pedagogical approach, others (Benin, Burkina-Faso, Cameroon, Côte d'Ivoire, Democratic Republic of Congo, Ghana, Mali, Niger, Senegal, Sierra Leone, Togo) emphasise the development of skills through projects (using a skills-based approach, or SBA) or problem scenarios (in scenario-based learning, or SBL). In this case, reliance on play-based learning is less explicit. One can see that most ECCE curricula emphasize skills-based approaches, as this is generally recommended in curricula at higher levels of education. This implies that there is a certain amount of consistency between the pedagogical approaches recommended for different levels of education. Given that play-based learning can promote the development of expected skills, the link between play and skills is not clearly explained; this could raise questions related to comprehension and general understanding concerning the link between play-based learning and skills development in the teaching and learning process from a very early age.

The curricula are organised by theme, by area of learning/field and/or activity. For example, Ghana proposes an integrated thematic model. Its curriculum is organised around themes inspired by the children's daily lives rather than a subject by a progression through the subjects. The stated goal is linking knowledge in different fields to teach problem-solving skills. According to the Ghana curricula, the reason for the integrated thematic approach is that children acquire knowledge more effectively through interconnected and consistent learning activities. Those countries that chose a theme-centric approach are also the ones who propose organising space by learning centre. It is interesting to note that Chad is the only French-speaking country to have adopted the thematic approach. All the other countries that recommend it are English-speaking (Ghana, Nigeria, and Liberia). Countries using thematic instruction also share the importance of idea of content appropriation by children and the will to involve communities in school life.

Finally, one advantage of the Liberia curriculum is its emphasis on integrating students with special needs and on individualised learning so that each child has access to activities necessary for their individual development. It also provides for the use a protocol in the event of a disagreement between pupils, for example, while working on a group assignment. This "agree to disagree" approach helps children learn to respect and listen to each other, even when they disagree with others' ideas. This basic concept lays the foundation for critical thinking and collaboration.

SCIENCE AND TECHNOLOGY AWARENESS

Almost all country curricula (14 out of 18 countries) contain a specific subject area dedicated to science and technology. While Mali, Niger, Nigeria, and Sierra Leone do not dedicate a specific subject area to Science and Technology Awareness (STA), they address subjects such as the environment, water and "sensory education." Among countries that have a specific subject area, only eight (Angola, Benin, Cabo Verde, Chad, Côte d'Ivoire, The Gambia, Ghana and Liberia) explicitly define STA and clarify the scope of this area. With respect to technology awareness, it was found that most of the proposed technologies were a form of Information and Communication Technologies (ICTs), effectively excluding a broader perspective, such as that offered by Engineering Technologies, Medical Technologies, Energy and Environmental Technologies and Transport and Mobility Technologies. These broader dimensions of technology are either insufficiently considered or not considered at all. In this subject area, a list of skills to be developed is often included, but rarely alongside a definition of the scope. Nearly all curricula mention the areas of health and nature, but few truly connect these to a scientific approach. Health is often limited to good hygiene practices, such as teaching proper handwashing techniques. On the theme of nature, there is little or no mention of the causal link between human activity and climate.

THE CATEGORISATION OF SCIENCE AND TECHNOLOGY AWARENESS-RAISING ACTIVITIES

The activities proposed in the curricula were analysed using the categories devised by Chauvet Chanoine to determine whether they explicitly proposed one or more specific, practical activities in each category (yes or no). The analysis showed that the most common activities involve sensory experiences and categorisation. The explanatory processes should be made more explicit, and it would be beneficial to further develop the rational process. The category of activity that was the hardest to identify was object conceptualisation. This can probably be explained by the fact that in curricula, technology awareness is usually quite superficial and often limited to the use of digital devices. In addition to these categories of activities, the researchers also looked for activities linked to "the causes and impacts of climate change." Besides Cabo Verde, no countries explicitly proposed this type of activity. It should be noted that the goal was identify activities going beyond an emphasis on discovering and respecting the environment and nature.

Activity	Frequency of STA activities
Sensory experiences: familiarising children with different objects and phenomena	14 countries/18
Categorisation: introducing children to the observation, description and categorisation of objects and phenomena by encouraging comparing and contrasting	13 countries/18
Explanatory process: developing rational questioning, introducing children to the search for rational explanations, identifying causality by encouraging observation, establishing relationships and verbalisation	10 countries/18
Object conceptualization: constructing "object-concepts" to expand points of view	4 countries/18
Rational process: familiarizing children with the identifiable and reproducible steps of an investigative approach, which are indispensable to a rational approach to the world	11 countries/18

TEACHING MATERIALS

With respect to STA teaching materials, the countries are classified based on how clearly the curricula describe the materials to be used. In the analysis of existing curricula, ten countries (Burkina-Faso, Cameroon, Chad, Côte d'Ivoire, The Gambia, Ghana, Liberia, Mali, Nigeria, and Senegal) and eight countries (Angola, Benin, Cabo Verde, Democratic Republic of Congo, Guinea-Bissau, Niger, Sierra Leone and Togo) provide a relatively brief list of materials. The teaching materials are often rudimentary. In general, the curricula recommend that teachers or educators use materials that can be easily found in their daily lives (recycled materials) or in nature, and that they involve communities. In comparison, materials used for mathematics awareness are often more complex. For technology, these materials can be toys or, as is more often the case, digital devices.

ASSESSMENT TOOLS

It is important to assess young learners' progress on knowledge, skills, and abilities. In ECCE, a formative assessment designed for use in education and methodological improvement requires tests and observation tools or guidelines for interpreting documents and other forms of children's expression that are directly linked to specific activities in the curriculum in areas such as STA. The design of tools, guidelines, and assessment procedures must be conceived to help teachers and educators understand and assess each child's way of thinking and reflection, to identify knowledge and skills gaps, conceptual difficulties, and emotions. Structured curricula with specific learning goals and planned learning activities can provide such curriculum-based tools. Engaging in face-to-face activities with small groups of children or with children individually while encouraging them to express themselves verbally and emotionally, to anticipate, plan and act, and to respond to the thoughts and suggestions of teachers/educators could help create a framework for a dynamic formative assessment (how a child responds to guidance) that goes hand in hand with assessment, guidance, and adaptive teaching. An assessment of the child's progress would allow the teacher to evaluate their work and to propose other activities to encourage continued learning. The assessment for specific STA areas is thus discussed in all of the curricula, but this discussion ranges from more or less explicit (Burkina Faso, Cameroon, Cabo Verde, Chad, The Gambia, Liberia, Nigeria and Senegal), with methods, tools and/or time slots, to relatively brief (Angola, Benin, Côte d'Ivoire, Democratic Republic of Congo, Ghana, Guinea-Bissau, Mali, Niger, Sierra Leone) with just a few indications or criteria. Nevertheless, the issue of formative assessment requires additional research to create a more relevant link between assessments for ECCE and those for other levels of education.

TEACHER PROFILE AND TRAINING

The profile of teachers/educators and their training are not specified in the analysed documents. The curriculum of Benin is the only one to explicitly describe the profile and training of teachers at this level. Guinea-Bissau also mentions potential initial training for ECCE teachers. It was also found that teachers at this level have different titles depending on the country: educator, schoolteacher, teacher, etc. There is also no mention of the optimal number of teachers needed in the classroom to attain the goals that have been set. The aim of the teacher or educator is to support (Coquidé, 2007) the young pupil in "familiarising themselves with nature and objects in a practical manner in order to build their experiential capital and to develop the first level of knowledge" (Ledrapier, 2007).

STRENGTHS, WEAKNESSES, OPPORTUNITIES, THREATS (SWOT)

The goal of education systems is to establish a framework within which children can learn and develop their skills. Since each country evolved in a different context, their education systems cannot be expected to have been set up to work in the same manner. Nonetheless, one can highlight some strengths and weaknesses, as well as opportunities and threats associated with integrating Science and Technology Awareness into ECCE curricula. This SWOT analysis sheds light on some relevant practices in learning and their appropriateness given the chosen teaching strategies and resources available.

STRENGTHS	WEAKNESSES
▪ Learning areas specific to STA ▪ Everyday life theme-based approach ▪ Progression in content between levels ▪ Community involvement in making teaching materials available	▪ Link between activities and overall child development in these countries ▪ Overloaded curricula ▪ Training and support for teachers/educators
OPPORTUNITIES	**THREATS**
▪ The integration of ECCE classes in primary schools for joint activities (mixed age) ▪ Co-management of common areas such as vegetable gardens or gardens ▪ Partnerships with parents and the community in hosting STA activities	▪ Infrastructure: class size, common areas, water, electricity, Internet, etc. ▪ Supply of teaching materials: books, printouts, technology, etc.

B. SUMMARY TABLE AND PROMISING PRACTICES

A summary table of the incorporation or assessment of STA in ECCE curricula is included below. It is based on an assessment of curricula and the literature on science awareness in nursery school. In the right column, the relevant fields contain information on one or more promising practices in the 18 countries analysed. Their choices are explained in the following section.

An initial reading helped establish the content and identify the similarities and distinctive features of the curricula. A second reading helped identify passages in the curricula that fall under the criteria in the summary table below. The summary table highlights the country or countries which included in their curricula an example illustrating the criteria contained in the matrix. The choice of promising activity is not a classification of best practices. Rather, it usually reflects the curriculum that places the greatest emphasis on or is most representative of the criterion in the summary table; the goal is to draw attention to the diversity of interesting practices identified in the curricula.

CRITERIA	PROMISING PRACTICES
1. **The purpose of ECCE** *To create a link with basic education*	**Angola** The ECCE curriculum in Angola is the only one to establish a very detailed link with the curriculum used in primary education. A chapter is dedicated to the organisation of primary education, containing the general objectives of basic education, the specific characteristics of primary education, the expected profile of pupils leaving primary school, the structure of the curriculum, an estimate of the weekly workload in hours by subject, as well as the specific objectives by subject. **Cabo Verde** The Cabo Verde curriculum dedicated a chapter to the importance of pedagogical continuity. It mentions that the transition from an early childhood education to primary education "may often be facilitated when early childhood professionals maintain an open relationship with the education community by visiting schools and exchange experience with teachers and other professionals. Today, school clusters often facilitate this type of relationship. It is important to note that ECCE professionals must communicate with teachers about assessment methods in early education and about the learning expected of children entering the compulsory education system."
2. **STA area of learning**	**Cameroon** The French-language curriculum of Cameroon envisions an STA subject area with five categories: introduction to mathematics, sensory education and perspective, information, and communications technology, and agropastoral and fish farming sciences. Although it does not explicitly define the subject of Science Awareness, few curricula offer such a granular differentiation. Each of the subareas is accompanied by a table of the distribution of resources with information about the distribution of abilities, knowledge, skills, and attitudes by learning level. Among curricula that included a technological component as part of Science Awareness, very few offered a clear distinction between information and communications technology (ICT) and the study of scientific and technological objects outside the realm of ICTs. Each of the subareas is explored using themes from daily life, such as "the human body, school life, the plant and animal world, professions, public transport, etc." Cameroon is also one of the few countries to highlight agronomic sciences to the point of detailing and differentiating between pastoral and fish farming activities. In addition to this relevant manner of organising STA, the curriculum includes another subject, "Everyday Life," which teaches children about prevention and hygiene. This, the French-language curriculum of Cameroon is one of the most comprehensive ones when it comes to areas of learning related to science, technology, and health education.
3. **The purpose of Science Awareness** *Define "Science Awareness"*	**Chad:** "Science Awareness means being open to the world, mobilising knowledge, abilities, and behavioural skills to describe, understand and explain everything which surrounds the child. Children engage in activities that allow them to invest in where they live, to understand their culture, lifestyle and responses to their geographic environment and climate, etc. These activities aim to create a scientific mindset based on curiosity, the ability to be surprised, explaining a problem, pointing out a causal relationship (CR) and communication in all its forms." The chapter on science awareness activities in the Chad curriculum begins by explicitly defining this subject area before listing specific objectives for the end of each learning cycle, laying out the main issues and describing the learning frameworks to be established to achieve said objectives. The curriculum of Chad is also distinguished from the others by the presence of a paragraph, albeit a brief one, about safety measures for the attention of teachers.

4. **The purpose of Technology Awareness** *Define "Technology Awareness" and specify the scope of technologies*	**Cabo Verde** Like the other curricula, Cabo Verde does not include a Technology Awareness subject area. However, it includes a "subject area on world knowledge," which is divided into two parts: "The technological world and the use of technology" and "educational continuity." It is noteworthy that it defines "technology awareness" without defining "science awareness." Usually, when one of the two subject areas is omitted, it is technology. Here, the emphasis is on technology and its use to foster an openness to the modern world, while ensuring that the most disadvantaged children have access to a telephone, camera or computer. **Ghana** The Ghana curriculum does not define a subject area for technology awareness, but it stresses the integration and use of information and communications technology as a learning tool in all areas of learning. It recommends that teachers use equipment such as the radio, telephones, and televisions during instruction.
5. **Teacher profile** *Describe the required profile as well as the initial training and procedure for continuing education.*	**Benin** Benin is the only country to specify the desired profile of teachers and the minimum knowledge which they must possess, but without describing a typical career path or a specific training or certification that would grant access to the profession. Although the desired profile description is brief, it contains information about knowledge, skills and attitudes expected from educators in the classroom. "Nursery school teachers must possess the following qualities: upstanding character; no stutter; clear articulation and good flow; welcoming, smiling, in a good mood; familiar with child psychology and able to accept children's weaknesses and mistakes to gradually help them overcome them; open and dynamic; believes in the children, encouraging them and inspiring them to study and tap into their latent intellectual potential; give the best of themselves for the sake of the emotional atmosphere in the classroom. Teachers must thus be guides and models for the groups of children and educators of which they are in charge; good organisers; good managers in all areas (hardware, time, land, facilities, furniture); creators who are able to develop pedagogical projects and make equipment and toys…Teachers with knowledge of psychology, pedagogy, group dynamics and childcare."

6. Categories of STA activities

a) Sensory experiences: Familiarise children with a variety of objects and phenomena. Use fine motor skills. Direct manipulation of objects.

Chad

All curricula include sensory activities. What varies from one curriculum to the next is where they take place and how they link up with the rest. Some curricula include experiential sensory activities for each area of activity, and others, like Chad, consider the sensory approach to be a separate subject area. It is noteworthy that Chad considers the "sensory approach and experiential discovery" to be a specific subarea of science awareness. Here are a few examples of sensory activities grouped together for the Petite, Moyenne and Grande sections: "recognizing and distinguishing sensations by using the five senses," "active outdoor observation: trees, plants, and insects," "using the five senses to conduct experiments and engage in discovery," "actively participating in discovery and gardening work."

Cameroon

"Sensory education and perspective" is a subarea of science and technology awareness. Learning activities requiring use of the senses that also correspond to scientific topics are summarized in tables. Each activity is broken down into knowledge, skills and attitudes depending on the level of learning, as can be seen from the example below.

Distribution des ressources en éducation sensorielle et perceptive

THÈME DE VIE 2: LE CORPS HUMAIN					
1ère Année			2ème Année		
Savoirs	Savoir-faire	Savoir-être	Savoirs	Savoir-faire	Savoir-être
La vue: - les positions; - les dimensions; - les couleurs.	- Dire les positions: debout - assis - couché; - ranger par grandeur: court/ long; -identifier les couleurs; -nommer les couleurs.	Avoir l'esprit scientifique	**La vue:** - les positions - les dimensions - les couleurs	-Identifier les positions: accroupie à genoux; -faire la difference entre long et court; -Composer les couleurs Violet (bleu + rouge); -Orange (rouge + jaune).	Avoir l'esprit scientifique
L'odorat: les odeurs	Distinguer la qualité des odeurs: bonnes et mauvaises odeurs		**L'odorat:** les odeurs	-Identifier les odeurs: odeurs fortes - faibles odeurs des produits de toilette (savon, lait, parfum...) -odeurs des produits pharmaceutiques (alcool...)	
Le toucher: - le poids - la température	-Estimer le poids à la main: lourd/léger; - Distinguer le chaud du froid		**Le toucher:** - le poids - la température	-Estimer le poids à la main: lourd /léger - Distinguer le chaud du froid	

Categories of STA activities

b) ***Categorisation process:*** *Developing the observation, description and categorisation of objects and phenomena through comparing and contrasting. Identifying, sorting, classifying.*

Ghana

The Ghana **curriculum offers an organisation** of areas of learning that reference themes related to the child's social life. Lessons about distinguishing and classifying living and non-living things are included in the subject area "All around us." For each subarea, an example of an activity is described and linked with the corresponding objectives and skills, as can be seen from the example below.

STRAND 6: ALL AROUND US

SUB STRAND: K1.6.1: LIVING AND NON-LIVING THINGS

Content Standard	Indicators and Exemplars	References	Core Competencies
K1.6.1.1 Demonstrate understanding of living and non-living things.	**K1.6.1.1.1 Talk about different types of things around us and classify them into living things and non-living things**	**WP6**	Communication and collaboration (CC)
	Exemplar:		
	In a community circle time, let learners recite poem or rhymes about some things around us. E.g. "Akoo ketewa bi" and talk about the key ideas in the poems	**LL1**	Personal Development and Leadership (PL)
	Take learners out to observe and identify things around them.	**LL2**	Personal Development and Leadership (PL)
	Let learners tell what they saw during the nature walk. Write their answers on the board	**LL3**	
	Discuss which of the things are living things and those that are not (*Living Things* grow, move, feed, etc. and *Non-Living Things* do not grow, do not move, do not feed, etc.).	**LL4**	Communication and Collaboration (CC)
	Assist learners to classify the list on the board into living and non-living things	**N3.1**	Creativity and Innovation (CI)

Categories of STA activities

c) ***Explanatory process:*** *Develop rational thought, teach pupils about how to search for rational explanations, identify causal relations by encouraging observation, questioning and linkage. Verbalise.*

Cameroon

The Cameroon curriculum offers instructors strategies for placing children in situations to encourage them to ask questions and conduct experiments to answer their own questions, as illustrated by the example below. "Teaching strategy": "By observing and sorting objects and materials and playing with them, the teacher will lead pupils to ask certain questions." "Skills": "Conduct an experiment to prove that air exists."

3.2.4 SCIENCES ET TECHNOLOGIES

Compétence 2: utiliser les notions de base en sciences et technologies.

Compétence à faire développer: résoudre les problèmes d'ordre scientifique et technologique.

Stratégies d'enseignement: pédagogie du jeu et pédagogie de projet

A partir des observations et des tris d'objets, de matières, des jeux de manipulation, l'enseignant va amener les apprenants à s'interroger eux-mêmes.

- La coopération entre les enfants dans le travail de groupe est attendue au cours des petites expérimentations et des séances de bricolage.
- La classe découverte est à exploiter.

Matériels didactiques: fruits, légumes, matière plastique, papier, fer, feuilles d'arbre (vertes), du bois, matétriel de récupération.

Tableau n° 20: distribution des ressources en sciences

Thème de vie 1: L'école					
1ère Année			2ème Année		
Savoirs	Savoir-faire	Savoir-être	Savoirs	Savoir-faire	Savoir-être
Les éléments naturels	-Identifier les éléments de la nature (terre, air, eau...); -Réaliser une expérience simple pour mettre en evidence la présence de l'air.	Aimer la nature	Les éléments naturels	-Identifier les éléments de la nature (terre, air, eau...); -Réaliser une expérience simple pour mettre en evidence la présence de l'air.	Aimer la nature

Categories of STA activities

d) Object conceptualization

First, manipulate an object or a phenomenon, understand the object or phenomenon, and then expand your point of view to other symbolic and general objects.

Mali

The pedagogical guide is characterised by the inclusion of and emphasis on the idea of a standard : "use an object as a reference to discover other standards that revolve around it." Standards are defined as references that the child can use to navigate the diversity of properties. By serving as common references for the understanding and communication of object characteristics and properties, standards play an important role in conceptualizing objects. For example, in building activities, teachers are asked to gradually lead children to use paper, clay or recycled materials to make an object or toy based on a model displayed in class. Teachers must lead children to build something based on their own design or idea. This activity helps children understand and work with objects from a familiar environment and to develop the creativity and innovation needed to conceptualise new objects. Knowledge of these standards will also allow the children to describe their creations in ever-greater detail. They will be able to describe the object's characteristics such as the colour, size, texture, and properties of the material they chose for their object. The example below describes the standards and their properties and is organised by the level at which the learning must take place.

PROPRIETES	ETALONS	SECTIONS	SENS
COULEUR	Rouge, vert, jaune, bleu	DES PETITS	VUE
	Rouge, vert, jaune, bleu avant l'apprentissage. du noir, du blanc, du marron, du gris, de l'orange et du violet.	DES MOYENS	
	Approfondissement et affinement des couleurs (les nuances : du plus foncé au plus clair)	DES GRANDS	
CONSISTANCE DE LA MATIERE	Solide-fragile, dur-mou, lisse-rugueux	DES PETITS	VUE TOUCHER
	Résistant -fragile, dur-mou, lisse-rugueux. approfondissement des étalons : plus dur-plus mou	DES MOYENS	
	Les différentes matières : du plus résistant au plus fragile ; du plus raide au plus souple. Les différents tissus : soie, laine, coton, velours	DES GRANDS	
QUALITE DE LA MATIERE EN RAPPORT AVEC LA LUMIERE	Transparent- opaque	DES PETITS	VUE
	Sombre – clair	DES MOYENS	
	Transparent – opaque ; brillant-mat	DES GRANDS	
DIMENSION	Grand – petit, gros-mince	DES PETITS	VUE TOUCHER
	Grand – petit ; gros-mince ; long – court;	DES MOYENS	
	Plus grand que, plus long que, plus court, plus mince, plus gros,	DES GRANDS	
POSITION DIRECTION	Devant – derrière, sur, sous, au milieu, en haut.	DES PETITS	VUE TOUCHE
	Apprentissage des étalons suivants : dessus – dessous ; à côté – de chaque côté	DES MOYENS	

Categories of STA activities

e) ***Rational process:***

Familiarise children with the necessary steps of a rational approach to the world. An investigative technique in which the process and steps are clearly identifiable and reproducible. Datasheets are used.

Cabo Verde

In the activity guide for preschool education, the subarea of the world of technology and the use of technology suggests research activities that the children can use to draw conclusions and establish causation by working with equipment and using the investigative process: "research activities: experimentation/investigation activities which children can use to draw their own conclusions."

Here is a list of suggestions made for teachers/educators to guide them in organising research activities: "design small projects or areas of interest about interesting subjects," "encourage healthy behaviours and habits," "invite people to come to the kindergarten to tell people about what they do for work," "create frequent and diverse opportunities for the children to enter into contact with nature by leading them to observe, discover and appreciate it," "create conditions to allow children to study an animal (direct observation, listening to stories, observing images and photographs, postcards, putting together an album with animal

	drawings),” “facilitate discussion and reflection about the positive and negative effects of human activity on the environment.” **Suggestions pour les éducateurs :** • Développer de petits projets ou des centres d'intérêt autour de sujets intéressants (par exemple, à partir de visites, d'histoires ou d'événements). • Encouragez les comportements et les habitudes sains (manger des légumes, faire de l'exercice, ne pas toucher ou manger des produits que vous ne connaissez pas, etc.) • Invitez des personnes à venir au jardin d'enfants et à dire aux enfants ce qu'elles font dans leur travail : couturière, menuisier, boulanger, médecin, infirmière, facteur, agriculteur ou autres spécialistes, etc. • Créer des occasions fréquentes et diversifiées pour les enfants d'entrer en contact avec la nature, en les amenant à l'observer, à la connaître et à l'apprécier. • Prévoir des activités de connaissance du corps et des soins à apporter - pour l'enfant, voir comment il grandit, comparer les étapes de sa propre croissance depuis qu'il est bébé (à l'aide de photos, par exemple) - les moyens de locomotion, les organes du corps. L'exploration des aspects liés au fonctionnement du corps permettra d'aborder des questions liées à l'éducation à la santé (nutrition, hygiène, etc.). • Promouvoir de petits projets et/ou activités sur la famille (les éléments de la famille, les liens, les rôles joués par ses membres, les soins, etc.) • Créer les conditions permettant à l'enfant d'étudier un animal (observation directe, écoute d'histoires, observation d'images et de photographies, cartes postales, discussions avec des personnes qui ont des animaux ou qui s'en occupent, réalisation d'un album avec des dessins d'animaux). • Apprenez à connaître certaines plantes (en particulier les plantes endémiques) et aidez l'enfant à apprendre à les soigner. • Construisez un petit jardin, semez des graines, faites un herbier. • Faciliter la discussion et la réflexion sur les effets favorables et défavorables de l'action humaine sur l'environnement.

7. **Teaching materials**

Lists

Liberia

In Liberia, the organisation of classroom space into centres of activity is central and paramount. It helps children move from one centre to another independently, and teachers can vary the number and categories of centres which they offer to pupils. Thanks to this system, teachers can offer more individualised activities to meet the needs of each pupil. Setting up these centres of learning requires space and equipment. The curriculum includes a list of materials that can be easily obtained and suggests calling upon the community to make sure that the centres are properly stocker with materials. In other words, a list of needed items may be posted outside a classroom, and parents or anyone connected to the children could bring in recycled materials. A general list of basic equipment was prepared for the science learning centre, and activity sheets with a specific list of materials needed for the activity are made available. The curriculum also suggests that teachers create a "museum" area dedicated to objects (found outdoors in nature, for example) that children would like to collect and exhibit in the classroom.

Example of basic materials		
Aquarium	Prism	Clock
Beans	Rubber bands	Powdered soap
seeds	Scale	Food colouring
basket	Shoeboxes	Garden tools
Coffee box	Stethoscope	hourglass
Cardboard box	Sundial	Lock and key
Funnel	Wood	nail
Glue	Bone	pliers
Kites	Fur	pulley
magnet	Hammer	Rubber hose
Old magazine	Liquid soap	screwdriver
Sticks (popsicle sticks?)	Measuring cup	sponge
stone	Plastic bag	Boat (toy)
Sandpaper	Spoon	Sodium bicarbonate
Screw	Sugar	Nuts and bolts
compass	Watering can	water
Tin can	candle	oil

8. **Assessment methods**

Assessment tools

Cameroon

In its curriculum, Cameroon emphasizes the importance of formative and summative assessments and mentions the importance of properly calibrating assessments to allow children to enter their zone of proximal development (ZPD), i.e. the zone in which learning is unleashed, without which the child cannot develop new skills. The curriculum also defines the formative and summative assessment methods. The table below is available in the curriculum.

Assessment matrix	***Acquired (A)***	***In the acquisition process (AP)***	***Not acquired (NA)***
Code	Green	Yellow	Red
Performance scale	Works without assistance	Works with occasional assistance	Works with frequent assistance

	The Gambia The Gambia curriculum offers a very effective assessment tool by providing teachers with worksheets to record pupil assessment data. In the appendices, one can find three types of blank worksheets that teachers can use to record data from pupil assessments. The first worksheet helps teachers to make sure that they have scheduled all the activities necessary to cover the skills that the children need to develop. The second worksheet is a journal in which teachers can write down their observations for each week of learning. This worksheet is also used to communicate with parents about the data observed and recorded for each child. Finally, blank sheets that teachers can use to organise their content for the week by day and by objective are also available and ready for use.

5. RECOMMENDATIONS

A. A DIAGNOSTIC TOOL FOR SCIENCE AND TECHNOLOGY AWARENESS

Considering the analysis of the content elements described in this report and the importance of taking into account cultural context and available resources, the following recommendations have been formulated in order to effectively incorporate Science and Technology Awareness (STA) into ECCE curricula in countries in West and Central Africa.

This section proposes developing a **diagnostic tool for integrating STA into ECCE curricula in light of the (non-exhaustive) challenges listed in this critical analysis.** Moreover, this recommendation is part of the holistic and systemic approach of a Curriculum Orientation Framework (COF) for the entire education system.

This specific tool completes and complements any existing tools used for a broader diagnostic of the curriculum process. Observations of classroom practices will also make it possible to refine the elements of this tool.

Care must be taken to ensure that the STA subject area is contextualised and endogenous by incorporating elements of local culture, traditions, and the natural environment so that young pupils can refer to their lives and everyday experiences in their environment outside of school.

This tool is an opportunity for the multidisciplinary teams within ministries and/or other supervisory authorities with specific expertise to communicate in a common language in order to evaluate and highlight the status and implementation of Science and Technology Awareness in their ECCA curricula, as well as to plan the design and revision of this subject area.

In a multidisciplinary approach, these teams could, for instance, include the following profiles (among others):

- *"Expert in preschool instruction":* in charge of evaluating and improving the quality of the curriculum for early childhood education.
- *"Expert in science instruction":* this expert, who is familiar with the relevant scientific disciplines for young children, will evaluate the presence and quality of scientific concepts in the curriculum by making sure that they are age- and developmentally appropriate.
- *"Expert in education technology":* able to recognize technological concepts relevant to ECCE and to evaluate their incorporation into the curriculum, this expert will also make sure that the technology made

available to children is adapted to their age and abilities; he or she will evaluate how this technology is incorporated into the curriculum to promote an awareness of science and technology.

- *"Expert in curriculum and/or teaching materials design for science and technology"*: will evaluate the consistency and relevance of integrating STA into ECCE curricula within a Curriculum Orientation Framework (COF), which itself is based on the national education policy; will check whether the teaching methods and STA activities are adapted to the abilities and interests of the children by taking overall child development into account; will analyse the quality of the assessment tools used to measure progress and the skills of the children in relation to awareness of science and technology.

In addition, these experts should work with ECCE teachers and educators and other stakeholders (teacher/educator trainers, inspectors, pedagogical advisors, school management, local communities, etc.) to conduct contextualised diagnostics and propose recommendations that would promote an effective integration of STA into ECCE curricula and contribute to the development of skills and to the quality of the teaching/learning process).

The summary table below describes five main stages, as well as specific proposals for action (a non-exhaustive list).

1. Context
2. Criteria and evaluation indicators in five areas: scientific and technological concepts, pedagogical approaches, the availability and accessibility of resources and materials, assessments of learning and teacher training.
3. Assessment methods.
4. Analysis of the results:
5. Recommendations and action plan

DIAGNOSTIC TOOL FOR THE STATUS OF SCIENCE AND TECHNOLOGY AWARENESS IN THE ECCE CURRICULUM

PART 1 | CONTEXT

Goals and expectations for incorporating science and technology awareness into the ECCE curriculum, the education system**,** and a community project.

PART 2 | CRITERIA AND EVALUATION INDICATORS

1. ***Scientific and technological concepts***

1. **Indicator: List and number of scientific and technological concepts included in the curriculum at every level.**

For example, expanding technological awareness to knowledge of how to make objects or change the environment to meet human needs.

2. **Indicator: The level of complexity and sophistication of scientific and technological concepts presented at each level.**

This indicator aims to evaluate how scientific and technological concepts evolve, becoming more complex, as children progress to different levels and to the Petite, Moyenne and Grande sections. The goal is to determine whether the curricula offer a consistent and skills- and age-appropriate progression.

Evaluation method: To evaluate this indicator, examine the pedagogical content and activities proposed at each level of the curriculum; analyse the complexity of the concepts presented and of the tasks assigned to children.

A few key issues that should be considered: Are the scientific and technological concepts presented age- and developmentally appropriate for the children in this context? Does the progression of concepts through the levels demonstrate a gradual increase in complexity? Are children exposed to a diversity of scientific and technological concepts as they move through the levels? Do the proposed tasks and activities reflect an understanding and mastery of the previously taught concepts?

Rating scale: Example of a scale from 1 to 5:

1: The concepts do not reflect a consistent and age-appropriate progression.
2: The progression is limited, but some concepts are addressed at the appropriate level.
3: The progression is somewhat consistent, but there are gaps.
4: Overall, the progression is consistent and age-appropriate.
5: The progression is very consistent, and concepts are presented in an appropriate manner at each level.

3. **Indicator: The degree of relevance and applicability of the scientific and technological concepts presented with respect to traditional or local knowledge, the current body of scientific knowledge and the basic education curriculum.**

2. ***Pedagogical approaches***
1. **Indicator: Type and number of activities related to science and technology proposed in the curricula.** 2. **Indicator: The degree of the children's interaction and engagement in science and technology awareness activities.** *This indicator aims to evaluate the extent to which the pedagogical methods implemented in ECCE curricula foster children's curiosity, interest and active engagement in activities related to science and technology. It helps determine whether the methods used help interest children in exploring, experimenting, and discovering the world around them.* *Evaluation method: To evaluate this indicator, observe science and technology awareness activities conducted in the classroom.* *A few key issues that should be considered: Are the activities designed in an interactive manner to encourage the active participation of children? Do the activities foster the children's curiosity and lead them to ask questions and explore? Are children encouraged to conduct experiments, make observations, and engage in discovery on their own? Are the activities adapted to the interests and levels of development of the children? Do the pedagogical methods used promote relying on discovery and exploration rather than direct instruction?* *Rating scale: Example of a scale from 1 to 5:* *1: The activities are mainly based on demonstrations or presentations without significant interaction with the children.* *2: The activities arouse some interest among the children, but there is limited active engagement.* *3: The activities encourage occasional interaction with the children, but this engagement is inconsistent.* *4: The activities encourage regular interaction and active engagement between children and scientific and technological discoveries.* *5: The activities are highly interactive and actively stimulate the curiosity of the children and their engagement in science and technology.*
3. ***Resources and materials***
1. **Indicator: The diversity of equipment and materials used in science and technology awareness activities.** *This indicator aims to evaluate the diversity of equipment and materials available and used in science and technology awareness activities in ECCE curricula. It helps determine whether the children have access to a wide range of equipment and materials for exploring and experimenting with different scientific and technological concepts.* *Evaluation method: To evaluate this indicator:* ▪ *Perform an inventory of equipment and materials: identify equipment and materials used for science and technology awareness activities in the assessed establishments. This may refer to recycled materials, microscopes, telescopes, experiment kits, educational toys related to science and tablets with educational apps.* ▪ *Categorize the equipment and materials based on the scientific and technological subject areas they cover. For example, equipment for physics, chemistry, ELS, technology, etc.* ▪ *Assess diversity and accessibility by analysing the list of equipment and materials to determine whether they cover a variety of scientific and technological areas and whether each area is represented by different types of equipment and materials.* ▪ *Assess the relevance with respect to adopting to the age of the children and to their overall level of development (while ensuring that their use is safe for children).*

- *Observe children during science and technology awareness activities to determine whether they have access to and interact with a variety of equipment and materials; note their engagement, curiosity and interest in this equipment.*

Rating scale: Example of a scale from 1 to 5:

1: There is very limited diversity of equipment and materials.
2: There is limited diversity, but some subject areas are covered.
3: There is average diversity, covering multiple subject areas, but improvements could be made.
4: There is sufficient diversity, covering a reasonable range of subject areas in science and technology.
5: There is excellent diversity, offering a wide variety of equipment and materials to explore many scientific and technological concepts.

2. **Indicator: The availability of books and pedagogical materials that address science in technology in a manner that is accessible to children.**

3. **Indicator: The use of ICTs (where appropriate) to support learning about science and technology.**

4. ***Learning assessment***

1. **Indicator: The diversity of tools, methods and practices used to measure pupils' progress and acquired skills.**

This indicator aims to assess the variety of tools, methods and practices used to measure pupils' progress and acquired skills in ECCE curricula. This involves determining whether assessments are adapted to children, covering different areas of learning, and offer a comprehensive vision of what they have accomplished.

Evaluation method: To evaluate this indicator:

- *Perform an inventory of assessment tools and identify the different types of assessment tools used to monitor children's progress and skills. This can include datasheets, classroom observations, interviews, the children's work, etc.*
- *Categorize the identified assessment methods based on learning areas and expected skills (linguistic, social, cognitive etc.) which they assess in this specific STA area.*
- *Evaluating diversity: Analyse the list of tools and assessment methods to determine whether they cover a variety of learning domains and are adapted to children in ECCE.*
- *Evaluate whether tools and assessment methods are appropriate for the age and overall development of children, ensuring that they are appropriate for measuring the progress of children at this stage of their development.*
- *Observe ongoing assessments to determine the diversity of implemented practices and evaluate future activities offered to children to develop their skills. This involves recording whether the evaluations are variety in their approach and whether they offer a complete vision of children's learning.*

Evaluation scale: Example of a scale from 1 to 5:

1: There is very limited diversity of assessment tools and methods, covering only one area of learning.
2: There is limited diversity, covering several areas of learning, but improvements are needed.
3: There is average diversity, covering multiple learning areas, but the assessment of some areas could be improved.
4: There is sufficient diversity, covering a reasonable range of learning areas with varied assessment practices.
5: There is excellent diversity with a wide variety of assessment tools, methods, and practices for measuring children's progress and skills in all areas of learning.

5. ***Teacher training***

1. **Indicator: *Number of specific training hours dedicated to science and technology awareness for teachers.***

2. **Indicator: *Teachers' participation in workshops, conferences and continuing education on science and technology.***

3. **Indicator: *Knowledge of pedagogical content and the incorporation of teachers' science and technology knowledge and skills into teaching activities.***

This indicator aims to evaluate the extent to which teachers include their pedagogical content knowledge and their skills in science and technology in their pedagogical practices. It helps determine whether teachers use their expertise to enrich and reinforce (scaffolding) STA activities offered to children to help them learn and become independent and whether teachers are thus positioning themselves as "builders of pedagogical architecture and providers of cultural wealth" (Lescouarch, 2018).

Evaluation method: To evaluate this indicator, observe the interactions of the teachers with children during activities on science and technology. A few key issues that should be considered:

1) *Are the teachers demonstrating basic knowledge of the scientific and technological areas that are the subject of the activities?*
2) *Are the teachers drawing on their abilities in science to answer the children's questions and further the discussions?*
3) *Are teachers actively encouraging children to explore, experiment and discover?*
4) *Are the teachers using examples and anecdotes from scientific experiments to illustrate the concepts being taught?*
5) *Are the teachers drawing parallels between the STA activities and the children's daily lives?*

Rating scale: Example of a scale from 1 to 5:

1: The teachers have very limited knowledge and skills in science and technology and are not applying these areas to their teaching.

2: The teachers have basic knowledge, but they incorporate very little of it into the activities.

3: The teachers display solid knowledge and skills, but their incorporation is uneven.

4: The teachers regularly use their knowledge and skills to enrich STA activities.

5: The teachers are consistently incorporating their knowledge and skills in science and technology to provide an enriching and stimulating learning experience.

PART 3 | EVALUATION METHODS

1. An analysis of the documents and pedagogical materials used in the curricula.
2. Classroom observation to evaluate pedagogical practices and use of resources.
3. Interviews with teachers and those in charge of education to obtain additional information about the incorporation processes.

PART 4 | ANALYSIS OF THE RESULTS

PART 5 | RECOMMENDATIONS AND ACTION PLAN

B. SCIENCES AND TECHNOLOGY AWARENESS (STA) CONTENT

This section suggests STA content for ECCE curricula. This would require reorganising the current content of the analysed curricula and creating new options to offer young learners a richer and more varied STA. Grouping content by theme was viewed as preferable over doing so by field of study (physics, chemistry, etc.) for greater relevance to ECCE. This content can be used in different years of ECCE (or even beyond), while maintaining a consistent progression in line with the child's level of development. This non-exhaustive list must be adapted and contextualised to determine its cultural relevance. The content must include example and materials adapted to the children's everyday environment.

- Children can grow edible vegetables and learn about where our food comes from

Science Awareness

Living things

Theme	*Sub-themes*
Learning about my body	Health and hygiene
	Parts of the human body
	The five senses
	The body map
	The needs of the human body
The animal world	Characteristics of living things
	Insects
	Livestock and fish farming practices
	Pets and how to care for them
	Wild animals and their habitats
The plant world	The decomposition of matter
	Fruits and vegetables (harvest and consumption)
	Plants and their flowers
	How gardening works (where my food comes
	Fruit and non-fruit trees
	From seed to plant

For each theme, it would be useful for teachers to develop scientific knowledge and skills which will be deployed through the content, and to provide key definitions. In this way, teachers could have access to a portfolio that briefly describes the scientific principles underpinning activities that they will conduct with the children. This approach can be formalised in a practical guide containing a collection of methods that teachers could apply step by step to promote the implementation of play-based activities during their classes.

Non-living things

Theme	*Sub-themes*
The materials	The qualities of surfaces
	Building materials
	The resistance of materials
	Natural/artificial materials
	Magnetic materials
Water	Buoyancy
	The states of matter
Air	Becoming aware of air
	Hot air and cold air
	Air and birds
	Air and music
Light and shadow	Light
	Colours
	Shadows
Celestial bodies	The sky and the stars
	Planet Earth
	The moon phases
	Time and how it's represented
The environment and climate change	Time and seasons
	The weather
	Recycling and composting
Natural resources	Renewable energy
	The water cycle
	Minerals and rocks

Technology Awareness

Objects

Theme	*Sub-themes*
Objects	Construction objects
	Mechanical objects
	Rolling objects
	Magnetic objects
	Balanced objects
	Electrical objects

ITC *(+)*

Theme	*Sub-themes*
Digital learning workshop	Device
	Software

(+) ITCs themselves are not part of a learning sequence, but the tools used serve as learning supports for content linked to other themes.

C. APPROACHES, TOOLS, EDUCATIONAL RESOURCES AND PROFESSIONAL PRACTICES

This section proposes several ways of thinking about inspiring STA practices, processes, and resources in ECCE and in primary school in order to highlight practical applications of science and technology in everyday life and to help children understand the extent to which scientific concepts and technological tools can address local challenges, improve living conditions and contribute to the sustainable development of their communities. These approaches must be adapted to local context and culture.

PEDAGOGICAL APPROACHES

These approaches, which are adapted to STA, teach pupils to ask questions, analyse problems and find creative solutions. The activities encourage teamwork, communication and sharing ideas. Children are led to seek solutions, formulate hypotheses, experiment, and evaluate results. They learn to express their creativity and explore different forms of expression. The ability to create through play is a necessary skill for all scientists. This leads young learners to develop executive functions, i.e. their ability to plan, flexibility (which includes imagination), self-control (control over the impulse to act out) and working memory (their memory of strategies or planned steps). Integrated activities also promote the understanding of basic mathematical concepts such as shapes, measures, patterns, sequences, and physical phenomena such as speed and wind force.

Project-based learning means that learners conduct a detailed and sometimes interdisciplinary analysis of a subject of their choosing. The added educational value of this approach is that it places the interest of the learner front and centre in the sense that it is the pupils themselves, individually or in small groups, who propose the subject that will become the focus of the project. This approach aims to enhance the pupils' creativity in solving difficult or poorly structured problems. The assumption is that if pupils select a subject that is interesting to them, this increases the likelihood that they will be involved in the research, thereby reinforcing their learning and increasing their chances of success. Children learn best when they are proactive and involved in their own learning process (Ledrapier. 2007). However, this approach requires upstream work from teachers because the schedule and the deliverables expected from the pupils must be ready by the start of the project.

STEAM (Science, Technology, Engineering, Arts and Mathematics) is an educational approach that incorporates science, technology, engineering, arts, and mathematics into the learning process. It encourages a holistic approach to these areas by combining knowledge and skills from them to foster creativity, problem solving and innovation. STEAM aims to develop transferable skills in children, such as critical thinking, collaboration, communication, and creative thinking. STEAM is offered in curricula that recommend setting up learning centres. STEAM is an educational approach that incorporates science, technology, engineering, arts, and mathematics into the learning process. It encourages a holistic approach to education by combining knowledge and skills from different areas to foster creativity, problem solving and innovation. STEAM aims to develop transferable skills in children, such as critical thinking, collaboration, communication, and creative thinking.

Example of an activity: Gardening and taking care of plants

Objectives: Developing an understanding of the life cycle of plants, observation skills, basic mathematics skills and use of technology.

- Step 1: Create a small garden either inside or outside the classroom. Ask children to participate in planting seeds or young plants. Tell them how they can care for the plants by watering them, exposing them to sunlight, etc.
- Step 2: Invite the children to regularly observe the plants and to record their observations in a journal. Encourage them to ask questions about plant growth and to see out answers by conducting research or by asking an expert (for example, a gardener or a teacher) for help.
- Step 3: Use technology (online resources or camera, etc.) to document plant growth. Children can take photos at different stages of the life cycle of plants and make a slideshow or a digital album to follow their evolution.
- Step 4: Incorporate mathematical elements and ask children to measure the height of plants, count the number of leaves or flowers, or observe changes in growth over time.

This activity allows children to develop their understanding of life sciences, their observation skills, as well as their basic mathematical skills (e.g. recognizing numbers from 1-10, counting, enumerating, developing a number sense, recognizing quantities, recognizing attributes of size/length, recognizing series, categorising, recognizing some geometric shapes, understanding the concept of space). They are also introduced to using technology to document and track the plants' progress.

Other examples of activities appropriate for children in preschools:

1. *Building structures:* Children can use building blocks, recycled materials, or construction kits to create simple structures. This promotes the understanding of basic concepts in engineering, physics, and geometry, while also developing fine motor skills and creativity.

2. *Exploring colours and shapes:* Art activities such as painting, cutting, and gluing can be incorporated into mathematical activities. The children can sort and classify objects by colour, create patterns and sequences by using different shapes and colours (e.g. with tangrams or the *sona* of the Tchokwe).

3. *Observing nature:* Outings and nature walks offer numerous opportunities for using the STEAM approach to learning. Children can observe plants, animals, insects and learn more about their habitat, growth, and life cycle by using tools such as magnifying glasses and binoculars.

4. *Experimenting with water:* Activities involving water are perfect for exploring basic concepts in science and mathematics. Children can have fun measuring and comparing volumes of water, observing floating and flowing objects, and creating water circuits to study movement and forces.

5. *Building simple electrical circuits:* Using safe and age-appropriate materials, the children can explore simple electrical circuits by using batteries, wires, and light bulbs. This helps them learn about basic concepts in electricity and engineering.

TEACHING TOOLS AND EDUCATIONAL RESOURCES

The following **teaching tools** may be recommended:

- *Experiment kits:* Kits with the necessary tools and materials for conducting age-appropriate simple scientific experiments, such as gardening kits, magnetic kits, light kits, etc.
- *Interactive visual materials:* Appealing videos, images, and illustrations to present scientific and technological concepts in a visual and stimulating manner.
- *Interactive applications:* Educational applications especially designed for young children, offering interactive activities to explore science, technology, engineering, and mathematics while having fun.
- *Building tools and manipulatives:* Building blocks, puzzles, gears, magnets, magnifying glasses, and other manipulatives that let children engage in hands-on experimentation and exploration of scientific and technological concepts.

There are many science **podcasts** for children that can be listened to like the radio. Their content focuses on providing adapted explanations, describing experiments that can be done at home with everyday objects, and also sharing tales and legends that help anchor pupils' learning.

Additional diverse resources for **mediating science** (television and radio shows, fairs and festivals, museum visits etc.) exist to arouse curiosity, arouse interest, learn through play, generate interest in the field, conduct museum visits, etc.

A few *examples*:

- *South Africa - Science Spaza* is a South African programme that aims to bring science to disadvantaged communities. “Spaza Centres” are established in working-class neighbourhoods, where science activities, exhibits and workshops are offered to encourage learning about science.
- *Cameroun - Caysti* is a digital centre where children over the age of 6 learn about digital technology, robotics, and coding.
- *Democratic Republic of Congo – Science and Technology Week* is a science festival held each year for the past decade with the goal of fostering scientific and technological literacy in young children and the public through science demonstrations, exhibits, conferences, and competitions.

- *Tanzania - Ubongo Kids* is a televised educational series produced in Tanzania and broadcast in 40 African countries. It targets children between the ages of seven and 14 and covers science, technology, engineering, mathematics, and social emotional learning. Kibena, Kiduchu, Koba, Baraka and Amani are the names of the main characters. They are curious children who are ready to overcome any challenges that may arise.
- *Belgium - MyMachine* is a unique program that runs during the school year. In the first stage, pupils in primary schools invent their "dream machine." Anything is possible if they really want it. In the second stage, students of higher education (engineers, product designers, game designers, etc.) translate these ideas into concrete, feasible concepts. In the third stage, secondary school students make the machine. This is a very exciting project that promotes children's creativity and innovation.
- *France - Lumni* is an educational program with participation from all the public audiovisual companies (Arte, France Médias Monde, France Télévisions, INA, Radio France and TV5Monde) for students and teachers. It provides access to culture, knowledge and learning for all children from the ages of 3-20 and covers all fields of study, from nursery school to the end of high school, organised by level, field of study and theme.

A prerequisite for quality STA learning and education is the professionalization of the occupation of ECCE teacher and/or educator. The occupation should be professionalized with a solid initial training and continuing education that accounts for participants' professional development needs, while focusing on knowledge of pedagogical content, skills, and the necessary teaching strategies for the effective implementation of STA.

This professionalization also means developing the teacher or educator's ability to adopt a collaborative, partnership-based approach, while involving families, the local communities, and teachers of other levels in the educational project, with a specific focus on STA.

6. CONCLUSION

The latest political summits dedicated to transforming education in Africa, the Tashkent Declaration, the objectives of the African Union's Agenda 2063, and the United Nations sustainable development goals reflect a clear international will to improve the quality of teaching and to ensure that all children will have access to an education. Moreover, the world today has recognized the importance of STEM in accelerating development on the African continent and overcoming global challenges. Many of the methods used to teach these disciplines are outdated, and Africa is underrepresented in the production of scientific knowledge, although there has been a noticeable improvement in recent years. To address this gap, the issue must be addressed from the very foundation of the education system. Indeed, if children are exposed to science and technology awareness earlier, they will be more likely to participate in these kinds of activities and will develop stronger skills and scientific literacy.

This is the backdrop against which a critical analysis of ECCE curricula in 18 African countries (Angola, Benin, Burkina Faso, Cameroon, Cabo Verde, Chad, Côte d'Ivoire, Democratic Republic of Congo, The Gambia, Ghana, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo) was conducted. The goal was to identify, catalogue and analyse the elements related to promoting STA in early childhood. In this analysis, researchers used a matrix based on the guiding principles and strategies contained in the Tashkent Declaration and on the content of scientific studies of activities organised to explore the world and matter for nursery schools. Country fact sheets containing elements of respective curricula were prepared based on the matrix, and a summary table was included to showcase examples of promising practices from the studied curricula. Similarities and differences between country curricula were discussed. This was followed by a SWOT (strengths, weaknesses, opportunities, and threats) analysis of the development of STA in early childhood. Some inspiring practices from the South and the North were proposed, and recommendations were formulated. The final report was enhanced with a diagnostic tool for evaluating the incorporation of STA to ECCE for use by experts at education ministries as well as with a list of recommended content, organised by theme.

This report helps set out the principles for developing STA in ECCE by highlighting the role of STA and the appropriate pedagogical approaches to promoting it. In short, the physical, active involvement of children in the process of learning about science in nursery schools encourages their natural curiosity, develops fine motor skills and coordination, strengthens their observation skills and their investigative spirit, and promotes linguistic development and logical thinking. But the prerequisite for this is well-trained teachers with the necessary tools and fact sheets, appropriate and contextualized materials, good class organisation, balanced curricula with a transition to primary school, and sufficient levels of investment.

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