

The Influence of Cultural, Economic, and Educational Context on the Effectiveness of Science Education.

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Abstract:

The effectiveness of science education is closely dependent on cultural, economic and educational contexts. These three key elements mutually influence each other, impacting how sciences are perceived, the resources available for teaching them, and the way science education is organized. Understanding these interactions is fundamental to improving science education, making it more equitable and relevant, and thereby forming citizens capable of engaging with the current scientific world.

Keywords: Science education, cultural context, economic context, educational context, Influence, effectiveness.

Introduction:

Science education aims to develop enlightened citizens who are active participants in progress. However, its effectiveness is not universal, as it is

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profoundly shaped by cultural, economic, and educational contexts. These interconnected dimensions act as filters that influence both pedagogical practices and the learning experience of students. Examining the impact of these contexts is therefore fundamental to optimizing science education and ensuring its accessibility and relevance for all. From this perspective, our central problem statement is as follows: How and to what extent do cultural economic and educational contexts influence the effectiveness of science education? What are the implications of these interactions for pedagogical practices and the learning outcomes of learners?

1. The Crucial Influence of Cultural Context on the Effectiveness of Science Education:

1.1. Cultural Context - The Bedrock of Values and Beliefs: For science education to flourish in a country, a favorable cultural environment is essential. This cultural context, primarily composed of the values and beliefs of the population, profoundly shapes how children approach and integrate scientific knowledge. Studies have shown that societal values significantly influence students' engagement with science (Lee & Chang, 2019, p. 45). Let's illustrate this with two contrasting scenarios:

1.1.1. A Culture Valuing Education and Science: In Asia, nations like South Korea and Singapore traditionally cultivate a high regard for education. Families there invest considerably to ensure their children's academic success, particularly in science. A strong belief in the role of science and technology for national progress is widely shared. The result: Students in these countries often demonstrate excellent performance in science.

1.1.2. A Culture with a Low Priority for Science or a Mistrust Thereof: In some communities where ancestral traditions are deeply rooted, scientific explanations of the world may sometimes conflict with established beliefs. If adherence to traditional explanations takes precedence, openness to learning science at school may be limited, making the teaching of certain subjects delicate (Cobern & Aikenhead, 1998, p. 55). Consequently, when a culture perceives science as important, useful, and accessible to all, science education has a strong chance of thriving. Students are more motivated, families support the school, and society as a whole values this discipline (Jegede, 1995 p.119). Conversely, if science is not considered a priority or if negative prejudices exist, even with competent teachers, it becomes difficult to generate interest and effectively teach science to children (Ogawa 1995 p. 588).

1.2. Pedagogical Traditions - The Legacy of Teaching Methods: Each culture carries within it specific pedagogical traditions, the customary methods of teaching and learning within the educational system. The introduction of new approaches to science education can encounter resistance from these established traditions. The impact of these traditions on the adoption of new pedagogical methods is a crucial factor to consider (Garcia et al., 2021 p.103).

1.2.1. Example of a Shift in Pedagogical Approach: Consider a country where science education has always relied on attentively listening to the teacher's explanations and memorizing definitions and formulas. Students are accustomed to passivity in class, note-taking, and recitation. The arrival of a new policy advocating inquiry and critical thinking, encouraging experiments, questions, the autonomous search for answers, and discussion can lead to:

Resistance to change: Teachers entrenched in lecture-based methods may find it difficult to adopt a more exploratory approach, perceiving it as a waste of time or a lack of control.

Negative perception: Parents may question the value of seeing their children "playing" in class instead of attentively listening and acquiring factual knowledge, doubting the seriousness and effectiveness of the new method.

Difficulty in implementation: Students, accustomed to a passive role may struggle to take initiative, ask questions, or design experiments, feeling disoriented without clear instructions.

The success of this new policy often requires an adaptation period for teachers, students, and parents, as well as a gradual awareness of the benefits of these new approaches for a deeper understanding of science. Adequate support and training are essential.

1.3. Language and Communication - The Vehicle of Understanding: If the language of science instruction differs from the students' mother tongue, it can constitute a major obstacle to learning. Language as a barrier to the acquisition of complex scientific concepts is a significant concern in multilingual contexts (Cummins, 2000, p.78). Imagine the difficulty of assimilating complex concepts such as photosynthesis or chemical reactions in a language that is not well understood. To ensure inclusive and effective science education for all, particular attention must be paid to the language used and the methods of communication in the classroom. An informed

science education policy must imperatively consider various strategies to improve the learning experience.

1.3 Strategies for Effective Science Education:

1.3.1. Strategies for Linguistically Inclusive Science Education:

1.3.1.1. Consider linguistic diversity: Recognizing and valuing the different languages spoken by students is a crucial first step. This implies implementing adapted pedagogical strategies to support learners whose language of instruction is not the primary language they use at home. Here are some concrete approaches:

-Use of rich and varied visual aids: Images, diagrams, graphs, videos, and hands-on activities can transcend linguistic barriers and facilitate the understanding of scientific concepts. A well-designed diagram of a plant cell will be more accessible than a lengthy textual explanation. (UNESCO, 2017, p.35).

-Use of translators or linguistic assistants: Where possible, the presence of individuals capable of translating key concepts into students' mother tongues can be extremely beneficial, especially when introducing new and complex notions. This can be done through multilingual teaching assistants or translated resources. (García & Kleifgen, 2010, p.78)

-Use of multilingual digital resources: An increasing number of educational platforms and applications offer scientific content in different languages. Leveraging these tools can make learning more accessible and autonomous for non-native speakers. (Cummins, 2000, p. 165)

-Encouraging plurilingualism in the classroom: Valuing students' linguistic knowledge by allowing them to use their mother tongue to discuss in small groups or to clarify ideas among peers can build their confidence and facilitate their engagement with science.(Council of Europe, 2001, p. 110)

-Simplifying the language of instruction: Teachers can be trained to use clear, concise, and progressive language when introducing new scientific concepts, avoiding overly technical jargon at the beginning and gradually introducing it with explanations and examples. (Gibbons, 2002, p. 45)

-Using culturally relevant analogies and metaphors: Connecting scientific concepts to experiences or cultural references familiar to students can facilitate their understanding and memorization, taking into account their linguistic and cultural background. The aim is to build bridges between new scientific knowledge and students' existing knowledge, rooted in their culture, language, and daily experiences. This makes the abstract more concrete and the new more familiar. (Aikenhead, 2006, p. 89)

1.3.1.2. Some Concrete Examples of Culturally Relevant Analogies:

- Photosynthesis compared to the growth of plants used in cooking or traditional medicine:

Scientific Concept: Photosynthesis (how plants use sunlight, water, and carbon dioxide to produce their food).

Cultural Analogy: The growth of aromatic herbs like mint, parsley, or traditional medicinal plants known to students and their families. The teacher can explain that just as these plants need sunlight to grow and

become green and full of life, other plants work in the same way through photosynthesis. One can even talk about the importance of "sun" (light) as a source of energy for the plant, a bit like fire is essential for cooking. (Gay 2010, p. 112)

The structure of the atom compared to the structure of a date:

-Scientific Concept: The structure of the atom (a central nucleus with protons and neutrons, and electrons orbiting around it).

Cultural Analogy: The date, a very common and appreciated fruit in Algeria. The hard pit in the center can represent the nucleus of the atom, and the flesh around it can represent the electron cloud. This analogy, although simplified, allows young students to visualize the idea of a center and something surrounding it. The teacher can then refine the explanation by specifying the differences, but the starting point is a concrete and familiar image. (Ladson-Billings, 1995, p. 480)

1.3.1.3. Taking Linguistic and Cultural Background into Account

-Using the mother tongue as a starting point: Explain certain scientific concepts using words and expressions familiar to students in their

First language can facilitate initial understanding. Then, gradually introduce the scientific vocabulary in Standard Arabic or French. (Cummins, 2000, p. 195; Gibbons, 2002, p. 60)

-Specific cultural references: Integrate examples related to local history traditions, crafts, or emblematic figures of the student's culture to make

learning more relevant and engaging. (Gay, 2010, p. 115; Ladson-Billings 1995, p. 478)

-Awareness of cultural representations: Be attentive to potential cultural beliefs or representations that could influence the perception of scientific concepts and address them with sensitivity and open-mindedness. (Cobern & Aikenhead, 1998, p. 48; Ogawa, 1995, p. 585)

By integrating these culturally relevant analogies and metaphors, science education becomes more accessible, more meaningful, and more rooted in students' experiences, thereby fostering better understanding and increased interest in scientific disciplines.

1.3.1.4. Other linguistic strategies:

-Extra time and individualized support: Offering personalized support and extra time to students who have linguistic difficulties in science can allow them to progress at their own pace and bridge their gaps.

-Adapted assessments: Assessment methods should take into account students' linguistic skills. Prioritize assessments based on the understanding of concepts rather than perfect language proficiency, for example, by using visual aids or non-verbal responses when relevant.

By integrating these concrete strategies, a science education policy can truly address all students, regardless of their language of origin, and foster a deep and lasting understanding of scientific concepts.

1.4. Role of Gender - Combating Stereotypes:

1.4.1. Persistent stereotypes and their influence: In some cultures preconceived and erroneous ideas persist that "science is more for boys" while "girls excel more in languages or literature." These gender stereotypes, although unfounded, can have a significant impact on academic paths and career choices.

Influence on choices: These stereotypes can unconsciously influence the aspirations of girls and boys, leading them to self-censor or be directed towards specific fields of study, thus limiting their potential and perpetuating inequalities. A progressive science education policy must clearly state that science is a field open to all, regardless of gender! It must actively work to deconstruct these false ideas through awareness campaigns, inspiring role models, and inclusive pedagogical approaches.

In conclusion, the effectiveness of science education is deeply rooted in the cultural context. An education policy that recognizes and adapts to these cultural dynamics, taking into account values, pedagogical traditions linguistic issues, and gender stereotypes, has a much greater chance of fostering successful and equitable science learning for all students.

2. The Crucial Impact of Economic Context on the Effectiveness of Science Education: The level of economic development of a country or region acts as a powerful lever, directly influencing the resources available for science education and, consequently, its effectiveness.

2.1. Resources, the Lifeblood of Education: Imagine wanting to build a super cool cabin in your garden. You would need wood, tools (hammer, saw, nails) perhaps help from an expert, and of course, money to acquire all of that.

Without sufficient financial resources, your cabin would remain a dream or be a rudimentary structure made of salvaged materials. Science education works similarly. A country's level of economic development is comparable to the money available to build this 'cabin' of science education. A prosperous country has more means to invest in education, including in science, which concretely translates into:

2.1.1. Adequate schools and materials:

2.1.1.1. In a favorable economic context: Institutions can equip themselves with modern and well-equipped laboratories (microscopes, chemicals, robots, computers), allowing students to learn through manipulation and observation, making science more engaging and accessible.

2.1.1.2. In a limited economic context: Schools may find themselves with obsolete laboratories, or even without a laboratory at all. Teachers are often forced to explain abstract concepts without practical demonstrations, and basic teaching materials (recent books, explanatory posters) may be lacking.

Example: A developed country can equip its science schools with 3D printers for designing models or tablets for interactive simulations. In a developing country with limited resources, students might have to make do with studying diagrams in worn-out textbooks.

2.2. Quality training for teachers:

2.2.1. In a favorable economic context: The state can invest in continuous and in-depth training for science teachers, keeping them informed of the

latest discoveries and best pedagogical practices through workshops and professional exchanges.

2.2.2. In a limited economic context: Teachers may not benefit from solid initial training or opportunities for updates, feeling overwhelmed or lacking inspiration to make their lessons engaging.

Example: A wealthy country can finance its science teachers' participation in international conferences, while a less affluent country might struggle to provide basic training for all its teachers.

2.3. Relevant curricula and learning tools:

2.3.1. In a favorable economic context: The country can allocate funds to the development of modern and adapted science curricula, accompanied by quality textbooks, interactive educational software, and online resources.

2.3.2. In a limited economic context: Curricula may be obsolete or ill-suited to local realities, and access to textbooks, often scarce and expensive, as well as to the internet for additional research, may be restricted.

Example: A country with resources can develop educational games for learning science, while a country with few resources might depend on photocopies of old textbooks.

2.4. Facilitated access to technologies:

2.4.1. In a favorable economic context: Schools can have computers, tablets and a fast internet connection, opening up a vast range of possibilities for science learning (research, simulations, videos, collaboration).

2.4.2. In a limited economic context: The lack of computer infrastructure and internet connectivity hinders students' access to digital resources. In a wealthy country, students can conduct virtual experiments to understand complex phenomena, while in a poor country, they may never have used a computer at school.

In summary: An economically developed country has the capacity to build a solid foundation for quality science education, with adequate infrastructure, well-trained teachers, and modern pedagogical tools. It's the equivalent of having all the necessary materials and tools to build a robust and fun cabin. Conversely, a country with limited resources, despite its best intentions, will encounter difficulties in implementing an ambitious science education policy. The lack of financial means can compromise access to basic resources comparable to trying to build a beautiful cabin without wood, without tools and without a budget to acquire them.

Thus, the effectiveness of science education depends not only on the relevance of the content taught but also on the financial means available to implement it correctly. An ambitious policy must be realistic and take into account the economic capacities of the country or region.

2.5. Transition to the Needs of the Labor Market: Beyond material resources the economic context also influences science education in another crucial way: by defining the scientific and technical skills valued by the labor market.

Imagine you are learning a trade. To maximize your chances of finding a job after your studies, it is wise to choose a field where demand is high. For example, if many companies are looking for plumbers, acquiring these skills will offer you better career prospects. Science education follows a similar logic. The needs of the labor market, that is, the skills sought by employers largely determine what is considered important to teach in science.

2.6. Why is alignment with labor needs essential for science education?

School does not simply transmit theoretical knowledge; it also prepares young people for their future professional lives. Science education adapted to the demands of the labor market increases young people's chances of employment and contributes to the economic development of their country.

- **Agriculture-dominant economy:**

Market needs: Knowledge in biology (botany, zoology), chemistry (soil science, fertilizers), physics (agricultural mechanics, irrigation), and potentially in agricultural economics.

Adapted teaching: Emphasis on practical applications directly usable in agricultural holdings or local agri-food industries. A country with a strong agricultural tradition might have specialized schools in modern agricultural techniques and sustainable resource management.

- **High-tech focused economy:**

Market needs: Computer engineers, software developers, electronics technicians, AI specialists, data scientists.

Adapted teaching: Priority to mathematics, physics (electricity, electronics) computer science, and potentially robotics and AI. South Korea, a technological leader, has an educational system strongly oriented towards STEM (science, technology, engineering, mathematics) to meet the needs of its cutting-edge industries.

- **Diversified economy:**

Market needs: More varied (biology for ecotourism, chemistry for crafts physics for maintenance, basic computer skills for all sectors).

Adapted teaching: More generalist approach at the beginning, with possibilities for later specialization depending on local opportunities. A tourist region rich in biodiversity might emphasize biology and ecology to train nature guides or conservation specialists.

In summary: An effective science education policy is not limited to the transmission of theoretical knowledge. It anticipates the future needs of the labor market and adapts the content and skills taught accordingly. By preparing young people for the jobs of tomorrow, it promotes their professional integration and contributes to the country's economic growth. It's like learning the most in-demand trade to maximize your chances of professional success.

2.7. Socio-economic Inequalities - An Obstacle to Equity in Science: Finally the economic context also manifests itself through socio-economic inequalities within a country or region, creating disparities in access to quality science education. These disparities in wealth and resources among

families within the same country or region lead to significant inequalities in access to quality science education. The work of Bourdieu and Passeron (1977, p.150) highlights how social inequalities are reproduced through the education system. Imagine a cycling race where some children have ultra-modern and lightweight bicycles, provided by wealthy parents, while others struggle on old and heavy bicycles, or even have to run on foot due to lack of means. It is evident that the better equipped have a considerable advantage.

2.7.1. The concrete consequences of these inequalities:

- **Unequal resources within households:**

Favored backgrounds: Access to science books, computers with internet for research, educational games with a scientific focus, and informed parental support, even private tutoring. Thus, a child with a telescope available is more likely to develop an interest in astronomy than a child who has never seen one.

Disadvantaged backgrounds: Lack of books, absence of computers and internet, and parents often less available or less equipped to help with science homework.

- **Disparities between schools:**

Affluent neighborhoods: Schools often better funded, equipped with well-equipped laboratories, modern scientific equipment, a rich library, and offering enriching educational outings.

Disadvantaged neighborhoods: Schools with limited resources, with outdated or non-existent laboratories, scarce scientific equipment, and few opportunities for school trips. Thus, students in a privileged school can carry out practical experiments with robots, while those in a disadvantaged school have to make do with illustrations in a textbook.

- **Unequal access to extracurricular opportunities:**

Favored backgrounds: Participation in science clubs, internships during holidays, visits to research centers, reinforcing interest and scientific knowledge. Thus, a summer robotics internship, accessible to children from wealthy families, gives them a definite advantage.

Disadvantaged backgrounds: These activities, often fee-paying, are inaccessible, limiting opportunities to discover science outside the school setting.

2.8. The Imperative Need for Specific Policies: Ignoring the influence of socio-economic inequalities on access to science education risks:

-Increasing disparities: Children who are already advantaged will see their opportunities for success in science multiply, while others will be left behind.

-Wasting talent: Bright young people in science, from disadvantaged backgrounds, may never have the chance to realize their potential.

-Consolidating an unjust society: Access to quality science education is a key factor for employment and a better quality of life. Unequal access perpetuates social injustices. To mitigate these disparities, public authorities can implement measures such as:

-Increased funding for schools in disadvantaged neighborhoods to improve their infrastructure and scientific equipment.

- The provision of scholarships or financial aid to enable children from modest families to participate in extracurricular science activities.
- The establishment of free science tutoring programs for students in difficulty.
- Teacher training to take into account inequalities and adapt their pedagogical methods to ensure the inclusion of all students.
- The development of free and accessible educational resources online or through other media.

For all children to have a chance to thrive in science, it is not enough to have excellent teachers. It is crucial to ensure that everyone has the 'right bike' to participate in the race, that is, equitable access to quality science education, regardless of their socio-economic background. Targeted policies are essential to compensate for initial disadvantages and make the race fairer for all.

In conclusion, the economic context, through the availability of resources the needs of the labor market, and socio-economic inequalities, exerts a profound and multifaceted influence on the effectiveness of science education. An ambitious and equitable policy must imperatively take these factors into account to guarantee quality access to all learners and prepare the future generation for economic and scientific challenges.

3. The Determining Influence of the Educational Context on the Effectiveness of Science Education: After exploring the cultural and economic dimensions, it is essential to examine the educational context itself.

The structure and organization of the education system, the quality of teachers, the existing curriculum, pedagogical practices, assessment systems and the overall level of development of the system are all internal factors that shape the effectiveness of any science education policy.

3.1. Educational Context - The Internal Mechanisms of Scientific Learning:

Imagine you want to organize a big party in your neighborhood. The way your neighborhood is structured will directly impact how you can organize this event.

3.1.1. Structure and organization of the education system: The architecture of learning: The way the education system is organized, whether centralized (with a single direction) or decentralized (with regional or local autonomy) significantly influences the implementation of a science education policy. The centralization or decentralization of the education system has direct implications for the uniformity and adaptability of policies (Hanushek & Woessmann, 2015, pp. 201-216).

3.1.1.1. Option 1: Centralized system: A single body (for example, a national ministry) makes all decisions regarding the theme, music, food, and activities of the party, and all streets must follow the same guidelines.

Advantage for science education: A new national policy can be disseminated and applied uniformly in all schools across the country, facilitating coherence and the achievement of common goals.

Disadvantage: A one-size-fits-all approach may not take into account regional specificities or the particular needs of schools. A policy effective in a

large city might not be so in a small rural school. Example: In France, the Ministry of National Education establishes the science curricula followed by all public schools, allowing for a relatively uniform implementation of new policies.

3.1.1.2. Option 2: Decentralized system: Each neighborhood or group decides on its own theme, music, and food, creating a diversity of events.

Advantage for science education: Each region or school has the freedom to adapt science education to its local context, resources, and culture. A well-equipped school can carry out ambitious projects, while another can focus on simple but effective experiments.

Disadvantage: It can be more difficult to guarantee an equivalent quality of science education across the entire territory. The implementation of a national policy can be slower and less homogeneous, requiring local adaptations. Example: In the United States, the significant autonomy of states and school districts in defining science curricula requires considerable flexibility from any national policy to be adopted and adapted locally.

The structure of the education system is the backbone of the party's organization. Centralized management facilitates the uniform application of new directives but may lack local flexibility. Decentralization allows for adaptation to specific needs but complicates ensuring homogeneous quality. Any science education policy must contend with this structure to maximize its effectiveness.

3.1.2. Quality and training of teachers: The conductors of learning

If you want to learn to play an instrument, having a good teacher is essential. Even with the best instrument and sheet music, an incompetent teacher will hinder your progress. Similarly, the quality of teachers is a pillar of student success in science. Their initial and ongoing training, their motivation, and the support they receive are crucial for the effective implementation of any education policy. Solid teacher training (Darling-Hammond, 2010, p. 29) is crucial for effective science teaching.

What characterizes a good science teacher?

-Solid training: A deep understanding of scientific concepts and effective pedagogies, updated through continuous professional development.

-Motivation and passion: A contagious enthusiasm for science, capable of sparking students' curiosity and engagement.

-Adequate support: Access to teaching resources, collaboration opportunities, and recognition of their work by the institution.

Why must a science education policy be concerned with teachers?

Because even the most innovative policy, with modern curricula and equipped laboratories, will remain a dead letter without teachers capable of implementing it competently and enthusiastically.

-Lack of training: Can lead to insufficient mastery of content or teaching methods.

-Lack of motivation: Can result in unengaging lessons and student disinterest.

-Lack of support: Can generate feelings of isolation and discouragement.

To train champions in science, you need competent and passionate coaches: well-trained and supported teachers. An effective science education policy must therefore prioritize investing in the quality of its teachers.

3.1.3. Existing curriculum and pedagogical practices: The playing field of innovation: Imagine you have a tried-and-true cake recipe. If someone offers you a radically different recipe, you will probably hesitate to completely change your habits. You might prefer to gradually integrate a few new ideas into your usual method. Similarly, a new science education policy must integrate with the existing curriculum and take into account current pedagogical practices. Ignoring these realities can lead to resistance and difficult implementation.

Why consider the existing?

-Teachers' habits: A sudden change can be destabilizing and difficult to adopt.

-Students' habits: A radical change in learning methods can confuse them.

-Curriculum organization: The new policy must logically integrate with the progression of learning.

-Resource availability: The new policy must be feasible with existing resources.

Consequences of ignoring the existing:

-Resistance to change.

-Difficulty in implementation.

-Confusion among students.

-Potential failure of the policy.

For the new recipe (policy) to be a success, it must be presented to the cooks (teachers) taking into account their know-how and the available ingredients (curriculum and resources). A gradual transition and support are essential for successful adoption.

3.1.4. Assessment systems: The compass of learning: If you are learning to ride a bicycle and are told that balance and pedaling are essential, but the final exam only covers the nomenclature of the parts, you will focus on memorization rather than practice. Similarly, assessment systems (exams tests) profoundly influence how science education is perceived and practiced. A policy focused on inquiry will be contradicted by an assessment centered on memorization.

Why are assessment systems crucial?

Because they signal to students and teachers what is truly valued and measured.

-Influence on teaching: Teachers will tend to prepare students for what will be assessed.

-Influence on learning: Students will focus their efforts on the assessed aspects.

-Perception of learning: Assessment shapes the understanding of what constitutes important scientific knowledge.

Consequences of a contradiction between policy and assessment:

-Weakening of the policy.

-Non-development of targeted skills.

-Frustration of teachers.

-Misinterpretation of results.

For the cooking (policy) learning to be effective, the final exam must assess the ability to cook (understand and apply science), and not just the knowledge of ingredients (memorization of facts).

3.1.5. Level of development of the education system: The reform construction site: Imagine two construction teams tasked with building a building. An experienced team with solid resources will be better able to implement a new plan than a team in training with limited means. Similarly a country with a well-established education system and significant resources will have a different capacity to implement a new policy compared to a country whose education system is developing and facing more fundamental challenges. Thus, a solid education system is an essential foundation for the successful adoption of new science education policies. Countries with developing systems often need to address more fundamental challenges before they can fully focus on ambitious reforms.

In conclusion, the effectiveness of a science education policy is intrinsically linked to the educational context in which it is deployed. The structure of the system, the quality and training of teachers, integration with the existing curriculum, alignment of pedagogical practices, coherence of assessment systems, and the overall level of development of the education system are all internal factors that must be carefully considered. A policy that ignores these internal realities risks encountering major obstacles and failing to achieve its objectives. The most effective policies are those that are designed taking these specificities into account and that involve close collaboration with all stakeholders in the education system.

Conclusion: The effectiveness of science education appears inseparable from the cultural, economic, and educational contexts in which it unfolds. These three dimensions, far from being isolated factors, interact in complex ways to shape learning opportunities, pedagogical practices, and, ultimately learners' achievements.

The cultural context shapes perceptions of science, the values placed on scientific knowledge, and the links established between science and society. The economic context, for its part, determines access to the material and human resources necessary for quality education, influencing infrastructure equipment, and teacher training. Finally, the educational context, through its policies, curricula, and organizational modes, structures science education and defines the priorities and preferred methods. Understanding this interplay of influences is crucial to move beyond a uniform vision of science education and adopt more contextualized approaches adapted to local realities.

Informed educational policies should thus take into account cultural specificities, strive to reduce economic inequalities, and optimize educational structures to foster relevant, engaging, and equitable science education for all learners. By recognizing and acting on these contextual levers, it becomes possible to significantly strengthen the effectiveness of science education and to train citizens capable of understanding contemporary scientific issues and actively contributing to an enlightened future.

Bibliography:

Aikenhead, G. S. (2006). *Science Education for Everyday Life: Evidence-based Practice*. Teachers College Press.

Bourdieu, P., & Passeron, J.-C. (1977). *La reproduction. Éléments pour une théorie du système d'enseignement*. Minuit, Paris.

Cobern, W. W., & Aikenhead, G. S. (1998). Cultural Studies of Science Education: Perspectives, Challenges and Agenda. In B. J. Fraser & K. G. Tobin (Eds.), *International Handbook of Science Education* (. Kluwer Academic Publishers.

Council of Europe. (2001). *Common European Framework of Reference for Languages: Learning, Teaching, Assessment*. Council of Europe Publishing.

Cummins, J. (2000). *Language, power, and pedagogy: Bilingual children in the crossfire*. Multilingual Matters, United Kingdom.

Darling-Hammond, L. (2010). "Teacher education and the future of the teaching profession". *European Journal of Teacher Education*, 33(1), 21-47, United Kingdom.

Garcia, A., López, B., & Martínez, C. (2021). The influence of pedagogical traditions on the implementation of inquiry-based science education. *Science Education International*, 32(2).

García, O., & Kleifgen, J. A. (2010). *Educating Emergent Bilinguals: Policies, Programs, and Practices for English Learners*. Teachers College Press.

Gay, G. (2010). *Culturally Responsive Teaching: Theory, Research, and Practice* (2nd ed.). Teachers College Press.

Gibbons, P. (2002). *Scaffolding Language, Scaffolding Learning: Teaching Second Language Learners in the Mainstream Classroom*. Heinemann.

Hanushek, E. A., & Woessmann, L. (2015). The knowledge capital of nations: Education and the economics of growth. MIT Press, États-Unis.

Jegede, O. J. (1995). Indigenous African Science and Technology: Implications for Science Education. In J. R. Campbell, *The Challenges of Science Education in Developing Countries*.

Ladson-Billings, G. (1995). Toward a Theory of Culturally Relevant Pedagogy. *American Educational Research Journal*, 32(3), 465-491.

Lee, G., & Chang, S. (2019). The role of cultural values in students' engagement with science learning. *Journal of Research in Science Teaching*, 56(1), 39-65, USA.

Ogawa, M. (1995). Science Education in a Multiscience Perspective. *Science Education*, 79(5).

UNESCO. (2017). *A Guide for Ensuring Inclusion and Equity in Education*. UNESCO.