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## Adapting Resource-Saving Laboratory Experiments for Functional Scientific Literacy in Hybrid Learning Modalities

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*(Image created via Canva, 2025)*

The Philippines faces persistent challenges in science education, limiting the development of functional scientific literacy among students. This deficiency is evident in poor performance in international assessments such as PISA and TIMSS, signaling the urgent need for systemic reforms and innovative solutions. This policy brief advocates for the strategic integration of resource-saving laboratory experiments including micro-lab kits, small-scale experiments, and virtual simulations within hybrid learning modalities. This approach provides a cost-effective, sustainable, and equitable means to strengthen hands-on learning, improve access to quality science education, and equip learners with critical thinking, problem-solving, and digital literacy skills essential for the 21st century. The proposed solution addresses resource constraints, enhances student engagement, and promotes sustainability by reducing waste and reliance on costly traditional laboratory materials. It is anchored in national education priorities, aligning with the MATATAG Curriculum (DepEd Order No. 010, s. 2024), DepEd ICT Roadmap (DO 016, s. 2023), and CHED CMO No. 75, s. 2017, while supporting EDCOM II's recommendations and the Quality Basic Education Development Plan (2025–2035). By implementing these measures, the Philippines can advance Sustainable Development Goal 4 and build a future-ready education system that fosters innovation, equity, and sustainable development.

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## Introduction

Functional scientific literacy—the ability to understand, interpret, and apply scientific information to real-world situations—is vital for individual empowerment and national development. It supports informed decisions on health, environment, and technology while driving innovation and economic growth.

Yet, Philippine students consistently underperform in international assessments like PISA and TIMSS, revealing persistent gaps in science education and underscoring the need for systemic reforms and innovative teaching approaches.

Key challenges include limited resources, inadequate infrastructure, a shortage of qualified science teachers, and disruptions from the COVID-19 pandemic. Many schools, especially in underserved areas, lack laboratory facilities and materials, restricting hands-on, inquiry-based learning. Teacher training in resource-conscious practices remains insufficient, and hybrid learning requires careful planning, robust infrastructure, and equitable access. The absence of clear policy guidelines for technology integration further compounds these issues.

This policy brief proposes integrating resource-saving laboratory experiments within hybrid learning as a practical solution. Combining hands-on inquiry with virtual labs and online resources can bridge resource gaps, enhance engagement, and promote sustainability by reducing waste and reliance on costly materials. Local programs such as DOST-SEI's Science Explorer and STARBOOKS show the feasibility of these strategies, having successfully delivered digital science content and mobile laboratory experiences to rural schools.

The proposal aligns with national priorities, including the MATATAG Curriculum, DepEd ICT Roadmap, and CHED CMO No. 75, ensuring compliance with outcomes-based education and teacher standards. It also supports EDCOM II's recommendations and the Quality Basic Education Development Plan (2025–2035), reinforcing its strategic role in advancing education transformation.

## Context and Problem Statement:

### The State of Science Education in the Philippines

Systemic challenges in Philippine science education persist even after reforms such as RA 10533. International assessments such as PISA and TIMSS show Filipino students scoring far below OECD averages, revealing gaps in knowledge, skills, and real-world application—hindering the development of a scientifically literate population vital for innovation and growth. Addressing these gaps aligns with national priorities

under the MATATAG Curriculum, DepEd ICT Roadmap, and EDCOM II's call for systemic improvements.

Hybrid laboratory models offer a practical solution by integrating resource-saving experiments into DepEd's Learning Recovery Plan and ICT Roadmap. TEIs must prepare future educators for these modalities, while CHED partnerships ensure compliance with outcomes-based standards (CMO No. 75, s. 2017). Implementation requires budget allocations for micro-lab kits and virtual lab licenses, supported by government funding or public–private partnerships. Regulatory updates should recognize hybrid lab facilitation in teacher workload and include technology-enabled instruction. These measures advance RA 10533 and SDG 4.7 by promoting sustainable, inclusive, and technology-driven science education.

Several interconnected factors contribute to this persistent challenge:

- **Resource Constraints-** Many schools, especially in rural and underserved areas, lack adequate laboratory facilities, equipment, and materials for hands-on experiments. This scarcity limits students' opportunities for inquiry-based learning and the development of practical scientific skills (Cerqueira et al. 2023; Obmerga & Marasigan, 2025; )
- **Inadequate Infrastructure-** Many schools lack adequate infrastructure—limited space, unreliable electricity, and poor internet—hindering tech-based and hybrid science programs (Department of Education, 2023; EDCOM II, 2023; Jarvis, 2023; Battestilli & Meral, 2023; Singh et al., 2021).
- **Shortage of Qualified Teachers-** The Philippines lacks qualified science teachers, especially in rural areas where hiring and retention are hardest (EDCOM II, 2023; Orbeta & Paqueo, 2022; Joaquin et al., 2020; Leila et al., 2022; Battestilli & Meral, 2023).
- **Insufficient Teacher Training-** Many qualified teachers lack ongoing training, which is vital to keep pace with new science, pedagogy, and technology for resource-saving and hybrid learning (Commission on Higher Education, 2017; Department of Education, 2024; Leila et al., 2022; Jarvis, 2023; Montefalcon & Quitaneg Abaniel, 2023).
- **Curriculum Gaps-** Although the K–12 science curriculum has been revised, concerns remain about its alignment with international standards and its emphasis on higher-order thinking. Regular reviews and updates are essential to ensure students are prepared for 21st-century challenges (Department of Education, 2024; OECD, 2023; Hardinata & Putri, 2019; Hofstein, 2017; EDCOM II, 2023).
- **Equity Concerns-** Socioeconomic disparities worsen challenges in science education, limiting access to quality



learning for disadvantaged students and perpetuating inequality. Ensuring equitable access to science education for all learners is a critical priority (Department of Education, 2024; OECD, 2023; Hardinata & Putri, 2019; Hofstein, 2017; EDCOM II, 2023).

- **Impact of COVID-19-** The COVID-19 pandemic exposed weaknesses in the Philippine education system, disrupting traditional teaching and emphasizing the need for flexible, resilient learning. It also highlighted the critical importance of digital literacy and technology access for teachers and students. (Joaquin et al., 2020; Leila et al., 2022; Singh et al., 2021; Battestilli & Meral, 2023; Department of Education, 2023).

## Proposed Solution:

### *A Multi-Pronged Approach*

To address these complex challenges and enhance functional scientific literacy among Filipino students, this policy brief proposes a comprehensive, multipronged approach that focuses on the strategic integration of resource-saving laboratory experiments within hybrid learning modalities. This approach comprises the following four key components:

1. **Resource-Saving Experiments.** Adopt cost-effective alternatives to traditional labs, including:
  - Micro Lab Kits – Portable kits for hands-on experiments in resource-limited schools.
  - Small-Scale Experiments – Use affordable, locally available materials for practical learning.
  - Virtual Labs & Simulations – Provide digital tools for experiments that are otherwise costly or unsafe.
2. **Hybrid Learning Modalities.** Integrate resource-saving experiments into blended environments combining online resources, virtual labs, and in-person sessions to ensure flexibility, accessibility, and engagement.
3. **Teacher Training and Support.** This component underscores the critical importance of investing in comprehensive professional development programs for science teachers. These programs should focus on the following.
4. **Resource-Saving Experiment Techniques.** Deliver comprehensive professional development focused on:
  - Resource-saving techniques
  - Hybrid learning pedagogies
  - Technology integration
  - Inquiry-based approaches
5. **Curriculum Integration.** Align resource-saving experiments with national standards through

- Curriculum Mapping - Mapping the existing curriculum to identify opportunities for integrating resource-saving experiments.
- Developing Learning Activities - Creating engaging and interactive learning activities that utilize micro-lab kits, small-scale experiments, and simulations.
- Providing Teacher Resources - Developing and disseminating teacher resources such as lesson plans, activity guides, and assessment tools.

## Policy Recommendations and Supporting Evidence

### *A Roadmap for Implementation*

To effectively implement this multipronged approach and achieve the desired outcomes, the following policy recommendations are crucial:

#### 1. Develop Clear National Guidelines

The Department of Education (DepEd) should lead in creating comprehensive national policy guidelines for resource-saving laboratory experiments within hybrid learning modalities.

*Supporting Evidence:*

- DepEd's MATATAG pilot schools have successfully integrated low-cost science activities in Grades 7 and 8 (Department of Education, 2024).
- EDCOM II Year Two Report emphasizes technology-enabled learning and foundational science skills development (EDCOM II, 2023).

#### 2. Invest in Teacher Training

Provide extensive professional development on resource-saving techniques, hybrid pedagogies, and technology integration.

*Supporting Evidence:*

- SEI-DOST's STAR Teacher Training Program includes modules on improvised science materials and ICT integration (Science Education Institute–DOST, 2023).
- CHED's CMO 75 promotes outcomes-based education and practical science skills (Commission on Higher Education, 2017).

#### 3. Integrate Resource-Saving Experiments into the Curriculum

Embed micro-lab kits, small-scale experiments, and virtual labs into the K–12 science curriculum.

*Supporting Evidence:*

- CHED's implementation of CMO 75 highlights the importance of practical science skills (Commission on Higher Education, 2017).
- DOST's STARBOOKS and Science Explorer programs deliver digital science content to rural schools (Science Education Institute–DOST, 2023).



#### 4. Provide Access to Tools and Infrastructure

Ensure schools especially in underserved areas that have access to micro-lab kits, virtual labs, and digital tools.

*Supporting Evidence:*

- DOST's Science Explorer and STARBOOKS initiatives have improved access to digital science resources in rural schools (Science Education Institute–DOST, 2023). As of 2023, Science Explorer mobile labs have reached over 500 schools nationwide, providing hands-on and digital science experiences to underserved communities. These initiatives demonstrate how resource-saving and technology-driven approaches can reduce dependency on costly materials while promoting digital literacy

#### Key Implementing Agencies and Target Groups:

DepEd, CHED, SEI–DOST, Regional Science Supervisors, Teacher Education Institutions (TEIs), school leaders, and science teachers.

#### Expected Outcomes

Implementing these recommendations is expected to yield significant positive outcomes and benefits, including:

1. **Enhanced Scientific Literacy** –  
*Target:* +10% improvement in National Science assessment scores (OECD, 2023; Orbeta & Paqueo, 2022).
2. **Improved Engagement and Motivation** –  
*Target:* 20% increase in student participation in science activities (Hofstein, 2017; Cresswell & Loughlin, 2017).
3. **Greater Access to Quality Science Education** –  
*Target:* Laboratory access ratio improved from 1:500 to 1:250 students (Caballes et al., 2024; Montefalcon & Quitaneg Abaniel, 2023).
4. **Sustainable and Cost-Effective Practices** –  
*Target:* 30% reduction in traditional lab material costs (Department of Education, 2024; Science Education Institute–DOST, 2023).
5. **Development of 21st-Century Skills** –  
*Target:* 80% of science teachers trained in hybrid and resource-saving techniques (Fauzi, 2019; Hardinata & Putri, 2019).
6. **Contribution to National Development** –  
*Target:* Increase STEM enrollment by 15% in three years (EDCOM II, 2023).
7. **Achievement of SDG 4** –  
*Target:* 100% of public secondary schools implementing hybrid lab models by 2030 (United Nations, 2015).

#### Conclusion:

Persistent challenges in Philippine science education demand urgent action. Integrating resource-saving laboratory

experiments within hybrid learning offers a practical solution to bridge resource gaps, boost engagement, and build functional scientific literacy a fundamental shift toward equitable, sustainable, and effective education.

This policy brief outlines a roadmap: invest in teacher training, provide resources and infrastructure, integrate these practices into the curriculum, and establish monitoring and evaluation mechanisms. These steps will empower educators and learners to reach their full potential.

This initiative is an investment in the nation's future in creating a scientifically literate citizenry that drives innovation, economic growth, and sustainability. We call on policymakers, educators, and stakeholders to act now.

Aligned with ongoing reforms such as the MATATAG Curriculum, DepEd's ICT Roadmap, CHED standards, and EDCOM II recommendations, this proposal supports the country's long-term education agenda. Together, let us ensure every Filipino student has access to quality science education and the skills to thrive in the 21st century.

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## Declaration

The authors used the ChatGPT-4.0 to refine the grammar, syntax, and expression in the text.

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## **The PNU Educational Policy Research, and Development Office**

The EPRDO is a specialized research center in the University focused on policy research and studies on teacher education. It is established to provide research-based policy recommendations to policy makers. It also serves as the clearing house for all data relevant to teacher education in the Philippines and beyond.

### **Vision**

The Philippine Normal University through the EPRDO aims to be an innovation hub of teacher education research and educational policy studies.

### **Mission**

To strengthen the culture of excellence in teacher education research and educational policy studies.

### **Objectives**

The EPRDO shall manage the University's research production, enhance human resource capabilities, and share expertise to other Teacher Education Institutions (TEIs) in the area of teacher education research

### **Strategies**

1. Establish and maintain a web-based university research portal that facilitates automated research management systems, and which also serves as the database of teacher education policies and teacher education research in the country and Southeast Asia.
2. Share research expertise and competence in teacher education research with other TEIs throughout the country;
3. Develop and disseminate the University research agenda
4. Design and implement the research capability program for faculty and staff;
5. Manage University's research production particularly the conduct of educational policy studies in education and teacher education; and
6. Serve as the implementing arm for research incentives and research ethics review.

### **Values**

SYNERGY (Working collaboratively as a team)  
 EFFICIENCY (Delivering research services efficiently)  
 EXCELLENCE (Achieving high quality research outputs)  
 PRODUCTIVITY (increasing research production of the University)

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