PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education

POLICY BRIEF SERIES

VOLUME 10 | ISSUE 7 | 2026 PRINT ISSN: 2984-9063 ONLINE ISSN: 2984-9071

When Content Falls Short: Reforming Science Preparation in Elementary Teacher Education

Al B. Besmonte, Allen A. Espinosa

Image Source: BU RCSMED FB page (2025) [Building a foundation for science literacy. Pre-service teachers from a LUC are actively participating in content enhancement and hands-on science experiments facilitated by a professor from SUC]

Persistent weaknesses in science learning outcomes in Philippine basic education are closely linked to how elementary teachers are prepared. National evidence shows that many teachers teach outside their field of specialization, a problem especially acute in elementary science. While the Department of Education's MATATAG Curriculum emphasizes conceptual understanding, inquiry, and hands-on learning, many elementary teachers enter classrooms without sufficient preparation in core science disciplines. Current policies governing the Bachelor of Elementary Education (BEEd) program position future teachers primarily as generalists, limiting opportunities to develop strong content knowledge in biology, chemistry, physics, and earth science. Empirical evidence from assessments, focus group discussions, and classroom observations indicates that these gaps undermine teachers' confidence, constrain instruction, and weaken implementation. Findings further show that targeted science preparation—through access to resources, hands-on learning, mentorship, and supportive environments—can substantially improve pre-service teachers' conceptual understanding and readiness to teach science. However, these gains are difficult to sustain when science preparation remains peripheral within teacher education programs. This policy brief therefore calls for a revision of teacher education, including strengthening science content preparation, reviewing and differentiating the BEEd curriculum, implementing admission mechanisms, expanding engagement of Teacher Education Institution faculty, and enhancing CHED monitoring so reforms translate into results.

Recommended Citation:

Besmonte,A.B. & Espinosa, A.A., When Content Falls Short: Reforming Science Preparation in Elementary Teacher Education, *Policy Brief Series 10 (7)*, pp. 1-X. Philippine Normal University Educational Policy Research and Development Office.

Introduction

EDCOM II (2024) reported that 62% of Filipino teachers are teaching outside their field of specialization, pointing to a persistent misalignment between teacher preparation and the actual needs of public schools. This issue is particularly pronounced at the elementary level, where teachers are expected to teach science despite being trained primarily as generalists. The specializations offered by universities and colleges do not adequately respond to the instructional demands of basic education, resulting in elementary teachers who are insufficiently prepared to teach foundational science concepts.

This challenge is rooted in existing teacher education policies. The Commission on Higher Education Memorandum Order (CMO) No. 74, s. 2017 prescribes the Bachelor of Elementary Education (BEEd) curriculum, which includes only two major science courses: Teaching Science in the Elementary Grades (Biology and Chemistry) and Teaching Science in the Elementary Grades (Physics, Earth and Space Science), each carrying three units. These courses emphasize pedagogical approaches rather than deep engagement with science content. Consequently, pre-service elementary teachers receive limited formal preparation in biology, chemistry, physics, and earth science.

Earlier policy frameworks, such as CMO No. 30, s. 2004 or the Revised Policies and Standards for Undergraduate Teacher Education Curriculum, similarly position BEEd graduates as generalists or as specialists in early childhood or special education. However, this earlier curriculum allocated a larger number of units to content courses in science, mathematics, and English, allowing for stronger integration of content and pedagogy. In light of current learning challenges, this structure may be more responsive to the demands of elementary science teaching than the present curriculum.

The consequences of inadequate content preparation are evident in student learning outcomes. Results from the Programme for International Student Assessment (PISA) in 2018 and 2022 show that more than 75% of Filipino learners scored below Level 2, the minimum level of proficiency, in science, mathematics, and reading. Despite having the longest instructional time among Southeast Asian countries, Philippine learners continue to underperform (OECD, 2024), suggesting that extended classroom time alone does not guarantee meaningful learning when teachers lack sufficient content mastery.

These concerns are further intensified by the ongoing implementation of the MATATAG Curriculum (DepEd Memo No. 54, s. 2023), which emphasizes cross-cutting concepts, hands-on and minds-on learning, and science and engineering practices. While the curriculum is designed to build on learners' prior experiences and promote deeper conceptual understanding, its successful implementation depends heavily on teachers' science content knowledge. Without adequate preparation at the pre-service level, elementary teachers are expected to teach science concepts for which they have received minimal formal training, risking the further magnification of systemic learning gaps.

This policy brief draws on findings from a study that examined pre-service elementary teachers' learning of science through hands-on activities and content enrichment. The evidence highlights substantial difficulties across major science domains and raises urgent concerns about the readiness of future elementary teachers to deliver the science curriculum effectively. In the context of persistent learning deficits and ongoing curriculum reforms, revising the elementary teacher education curriculum is necessary to ensure that science instruction in basic education is conceptually sound, engaging, and aligned with national education goals.

Situation of Pre-Service Elementary Teachers in Science Concepts

To identify areas requiring urgent intervention, the study examined the science competencies of pre-service elementary teachers using an assessment benchmarked at a 50% mean correct response rate as the minimum threshold for acceptable performance. Results revealed consistently low achievement across the four science domains assessed—biology, chemistry, physics, and earth science—with particularly weak performance in chemistry and physics. These findings indicate that many pre-service elementary teachers struggle with foundational science concepts expected to be taught in the elementary curriculum.

Qualitative data from focus group discussions (FGDs) provide further insight into these results. Pre-service teachers reported that biology concepts were difficult to understand due to complex terminology and challenges in grasping how biological processes interact. Chemistry and physics were perceived as especially abstract and confusing, largely because concepts were disconnected from real-world contexts. Many participants attributed these difficulties to their limited exposure to hands-on experiments during elementary and secondary education, noting that science instruction was often restricted to textbook-based discussions or chalkboard illustrations rather than actual experimentation.

Overall assessment results suggest that pre-service elementary teachers experience significant difficulty applying theoretical science knowledge to problem-solving and instructional contexts. This pattern reflects insufficient preparation in science content within their tertiary education and raises concerns about their readiness to teach science effectively. Limited content mastery constrains teachers' ability to explain concepts accurately, respond to student questions, and design meaningful learning activities, ultimately affecting student learning outcomes. This situation is also reflected in the persistently low passing rates in the Licensure Examination for Teachers (LET), which have remained below 50% over the past decade based on PRC data, underscoring long-standing gaps in content preparation rather than individual teacher deficiencies.

These challenges, however, should not be attributed solely to individual pre-service teachers. Rather, they point to broader structural issues in teacher preparation, particularly the limited emphasis on science content within the BEEd curriculum. Without sufficient opportunities to develop conceptual understanding and engage in authentic scientific practices, pre-service teachers enter classrooms with low confidence and limited instructional readiness.

The study further revealed that targeted interventions can address these gaps. Following the diagnostic assessment, a science content enhancement program incorporating hands-on experiments was developed and implemented. Training materials were designed and validated using the ADDIE model and facilitated by educators specializing in chemistry, earth science, and physics. Pre-service teachers were given opportunities to manipulate laboratory equipment, conduct simple experiments, solve problems through observation, and connect theoretical concepts to real-life phenomena.

Evidence from FGDs and classroom observations indicates that these experiences positively influenced pre-service teachers' engagement and perceptions of science learning. Participants reported increased interest, confidence, and conceptual understanding, describing their experiences as markedly different from their prior exposure to science education, which had largely emphasized memorization. These findings are consistent with earlier studies showing that hands-on, experiment-based learning enhances pre-service teachers' motivation and self-concept in science (Kazempour, 2014; Marsh et al., 2015; Paulick et al., 2017; Sorge et al., 2019).

Further observations revealed improvements in communication skills, questioning skills, and science process skills as pre-service teachers conducted experiments collaboratively and reported results through written and oral presentations. These patterns align with research demonstrating that experiment-based interventions positively affect both conceptual understanding and science-related self-concepts (Möller & Trautwein, 2015; Wolff et al., 2018; Atzert et al., 2020; Beudels et al., 2022). Similar outcomes have been observed in inquiry-based laboratory practices, which support the development of critical thinking, creativity, and research skills among pre-service teachers (Ünlü, Hacieminoğlu, & Yildiz, 2023).

When the same content enhancement program was extended to in-service elementary teachers in a city school division, comparable responses emerged. In-service teachers expressed enthusiasm and acknowledged that they had not experienced hands-on science experiments for many years. During round-table discussions, teachers identified key constraints to implementing hands-on science instruction in schools, including competing non-instructional tasks, limited instructional time, and reliance on video-based lessons as a practical alternative. These constraints further underscore the importance of strengthening science preparation at the pre-service level, where foundational competencies and confidence can be developed before teachers enter the classroom.

Taken together, these findings highlight a critical gap in the science preparation of pre-service elementary teachers and demonstrate the potential of content-focused, hands-on interventions to address this gap. Without systematic reforms in teacher education, current weaknesses in science instruction are likely to persist, undermining the goals of curriculum reforms and limiting opportunities for meaningful science learning in basic education.

Action Taken

To address the documented gaps in science content knowledge among pre-service elementary teachers, a science content enhancement program anchored on hands-on experimentation and structured instructional support was implemented in two community colleges in the Philippines. The intervention targeted pre-service teachers enrolled in Teaching Science in the Elementary Grades and was aligned with the PDP 2023–2028, which emphasizes improving education quality through strengthened teacher competencies.

The program was designed and implemented following the ADDIE model, ensuring that training materials were systematically developed, validated, and refined prior to full implementation. A multidisciplinary team composed of chemistry, biology, and physics educators facilitated the training, each handling one intact class per Local University and College (LUC). The intervention was conducted over five

consecutive weeks, allowing pre-service teachers to engage meaningfully with science concepts through repeated experimentation, guided reflection, and collaborative learning. Central to the intervention was the provision of structured support across four interrelated areas: access to learning resources, hands-on and field-based learning opportunities, sustained mentorship, and motivational support. Pre-service teachers were provided with actual laboratory tools, equipment, and teaching guides that enabled them to translate abstract science concepts into concrete understanding. Through hands-on experiments and simulated science teaching activities, participants developed greater confidence in manipulating materials, observing phenomena, and connecting theoretical concepts to real-world contexts.

Following the implementation with pre-service teachers, the same content enhancement program was extended to in-service elementary teachers in one city school division, with one teacher representing each elementary school. The responses of in-service teachers closely mirrored those of pre-service participants. Teachers expressed renewed interest and enthusiasm for science instruction, noting that they had not experienced hands-on science experiments for several years. During round-table discussions, they identified systemic constraints that limited the use of hands-on activities in classrooms, including competing non-instructional tasks, limited instructional time (typically 45 minutes per science class), and reliance on video-based lessons as a coping strategy.

These implementation experiences highlight critical policy lessons. While hands-on, content-focused interventions can substantially improve teachers' confidence and engagement, such approaches are difficult to sustain without strong pre-service preparation. Strengthening science content mastery, experiential learning, mentorship, and emotional support within teacher education programs is therefore essential to ensure that future elementary teachers are better equipped to implement inquiry-based science instruction under real classroom conditions and to support the goals of ongoing curriculum reforms. Learning from the experience of elementary pre-service teachers during the content and hands-on training, several recommendations were crafted:

Policy Recommendations

Strengthen Science Preparation in Pre-Service Elementary Teacher Training. All pre-service elementary teachers expected to teach science should undergo systematic science content enhancement integrated with hands-on experimentation. Teacher Education Institutions (TEIs) should ensure that science courses move beyond pedagogical techniques and provide sustained opportunities for content mastery, inquiry-based learning, and laboratory engagement. While the use of improvised materials can supplement instruction, access to appropriate science equipment and laboratory facilities should be treated as a minimum quality standard. Embedding experiential science learning within pre-service training is essential to developing conceptual understanding, instructional confidence, and critical thinking skills among future elementary teachers.

Review and Differentiate the BEEd Curriculum. Higher education institutions offering the Bachelor of Elementary Education (BEEd) program should undertake a systematic review of the curriculum to better align with the instructional realities of basic education. CHED should consider allowing differentiated BEEd tracks or specializations in science, mathematics, and English, particularly for teachers assigned to intermediate grades where subject-focused instruction is increasingly practiced. Such differentiation would enable pre-service teachers to develop deeper disciplinary competence while maintaining a strong foundation in pedagogy, thereby improving the quality of content delivery in elementary classrooms.

Implement Quality-Assured Admission Mechanisms for Teacher Education. TEIs should adopt rigorous, transparent, and quality-assured entrance assessments for teacher education programs to ensure that incoming pre-service teachers possess minimum competencies in reading comprehension, writing, and basic scientific and mathematical skills. Admission mechanisms should be paired with clear career guidance and orientation programs for senior high school students and their parents, helping applicants make informed decisions about career pathways. Where appropriate, bridging or remediation programs may be introduced to support promising applicants who require additional preparation, ensuring that quality assurance does not come at the expense of access and equity.

Strengthen Field Exposure and School-Based Engagement of TEI Faculty. To ensure that teacher preparation remains responsive to classroom realities, TEI faculty members should have structured exposure to DepEd classrooms through field immersion, collaborative teaching, or school-based research and extension activities. Teacher education should not rely solely on theoretical instruction; instead, faculty engagement with actual school contexts should inform curriculum design, instructional strategies, and assessment practices. Aligning TEI research and extension initiatives with basic education needs will help bridge persistent gaps between teacher preparation and classroom practice.

Enhance CHED Monitoring and Support for Teacher Education Institutions. CHED should strengthen the monitoring of TEIs—particularly LUCs—to ensure compliance with Certificate of Program Compliance (COPC) requirements. Monitoring should focus not only on enrollment growth but also on faculty qualifications, curriculum implementation, laboratory adequacy, and alignment with national education reforms. Where gaps are identified, CHED should complement regulatory oversight with targeted technical assistance and capacity-building support to help institutions meet minimum standards and improve program quality.

Implementation Considerations

While the proposed reforms are necessary, their implementation requires careful attention to resource and capacity constraints. Expanding science preparation will require investments in laboratory facilities, equipment, and faculty development, particularly in Local Universities and Colleges (LUCs) where resources are often limited. Phased implementation may be necessary, prioritizing institutions with existing capacity while providing targeted support to under-resourced TEIs. Partnerships with DepEd, SUCs, and industry stakeholders may also help augment laboratory access and training opportunities. In addition, faculty upskilling and workload adjustments should be considered to ensure that strengthened science preparation is sustainable over time.

Policy Recommendation	Expected Outcome
Strengthen science preparation in pre-service training	Improved teacher content mastery and instructional confidence in science
Differentiate the BEEd curriculum	Better alignment between teacher preparation and classroom demands in elementary science
Implement admission mechanisms	Higher quality intake of pre-service teachers with stronger foundational competencies
Strengthen field exposure of TEI faculty	Improved alignment between theory and classroom practice
Enhance CHED monitoring and support	Increased institutional accountability and improved program quality across TEIs

REFERENCES:

Atzert, R., John, R., Preisfeld, A., & Damerau, K. (2020). The influence of the criterial, social, and temporal reference norm on teaching in biology. Its cognitive and affective motivational impact]. Dissertation, University of Wuppertal, Germany. https://doi.org/10.1007/s40573-020-00114-x

Beudels, M. M., Preisfeld, A., & Damerau, K. (2022). Impact of an experiment-based intervention on pre-service primary school teachers' experiment-related and science teaching-related self-concepts. Interdisciplinary Journal of Environmental and Science Education, 18(1), e2258. https://doi.org/10.21601/ijese/11323

CHED MEMORANDUM ORDER number 74 series of 2017.

CHEd Memorandum Order number 30 series of 2004. Revised Policies and Standards for Undergraduate Teacher Education Curriculum.

DepEd Memo No. 54, series of 2023 Pilot Implementation of MATATAG Curriculum

Kazempour, M.S. (2014) I can't teach science! A case study of an elementary pre-service teacher's intersection of science experiences, beliefs, attitude, and self-efficacy. International Journal of Environmental & Science Education (2014), 9, 77-96I. DOI: 10.12973/ijese.2014.204a. http://www.ijese.net/makale_indir/IJESE_1322_article_58246405a0ef4.pdf

Marsh, H. W., Salah Abduljabbar, A., Parker, P. D., Abdelfattah, F., Nagengast, B., Möller, J., & Abu-Hilal, M. M. (2015). The internal/external frame of reference model of self-concept and achievement relations: Age-cohort and cross-cultural differences. American Educational Research Journal, 52(1), 168–202. https://doi.org/10.3102/0002831214549453

Möller, J., & Trautwein, U. (2015). Selbstkonzept [Selfconcept]. In E. Wild & J. Möller (Eds.), Pädagogische Psychologie (2nd ed.) (pp. 177–199). Heidelberg, Germany: Springer. https://doi.org/10.1007/978-_3-642-41291-2_8

OECD (2024) OECD Economic Outlook, Volume 2024 Issue 2 OECD Publishing, Paris, https://doi.org/10.1787/d8814e8b-en.

Paulick, I., Großschedl, J., Harms, U., & Möller, J. (2017). How teachers perceive their expertise: The role of dimensional and social comparisons. Contemporary Educational Psychology, 51, 114-122. https://doi.org/10.1016/j.cedpsych.2017.06.007

Philippine Development Plan 2023 - 2028

Second Congressional Commission on Education (2024). Miseducation: The failed system of Philippine education, EDCOM II year one report. Second Congressional Commission on Education.

Sorge, S., Keller, M. M., Neumann, K., & Möller, J. (2019). Investigating the relationship between pre-service physics teachers' professional knowledge, self-concept, and interest. Journal of Research in Science Teaching, 56(7), 937–955. https://doi.org/10.1002/tea.21534

Ünlü,P., Hacieminoğlu,E., Yildiz, N.G. (2023). A "light bulb moment": Lab experiments enhancing novelty and critical thinking designed by future teachers, Thinking Skills and Creativity, Volume 50, 2023, 101413, ISSN 1871-1871, https://doi.org/10.1016/j.tsc.2023.101413

Wolff, F., Helm, F., Zimmermann, F., Nagy, G., & Möller, J. (2018). On the effects of social, temporal, and dimensional comparisons on academic self-concept. Journal of Educational Psychology, 110(7), 1005– 1025. https://doi.org/10.1037/edu0000248

Declaration

Grammarly was automatically installed in Word and provides grammar suggestions.

ABOUT THE AUTHORS

Al B. Besmonte is an associate professor of Science Education and a technical staff at Bicol University Regional Center for Science and Mathematics Education Development under Office of the Vice President for Research, Development, and Extension in Legazpi City. His research interests include science education assessment, DRR education, and community research that leads to STEM lessons development.

Allen A Espinosa is a professor of Science Education at the College of Advanced Studies and a fellow at the Educational Policy Research and Development Office of the Philippine Normal University. His research covers a wide range of topics, including policy research in education, teacher education, information disorder, and social justice in education.

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)

The **Policy Brief Series** aims to provide observations, analyses, and insights by PNU faculty and researchers on various educational policy issues. The views contained in the policy briefs are those of the authors and do not necessarily represent the official views of the University.

The **Policy Brief Series** is published monthly by the **Philippine Normal University Educational Policy Research and Development Office** (PNU-EPRDO). The PNU-EPRDO oversees the editing, compiling, and printing of the policy brief.

Address
Room 205, Pedro Orata Hall
Philippine Normal University, Manila, Philippines 1000

https://www.facebook.com/pnueprdo