



Reframing Integrated STEM Education in the Philippines as a Policy Enactment

Glenn A. Atienza 

Queensland University of Technology

ABSTRACT

Integrated STEM education has emerged globally as a policy response to economic competitiveness, workforce readiness, national innovation, and complex global challenges. In the Philippines, STEM education is positioned as a strategic response to national development goals, such as economic and skills development among its citizens. Across national policies, integrated STEM is frequently framed as a coherent pedagogical solution—often articulated through curriculum standards, competency frameworks, and education reports. However, despite strong rhetorical coherence at the policy level, research consistently reports variability, ambiguity, and fragmentation in how integrated STEM is understood and practiced in schools. Much of the existing integrated STEM literature emphasizes curricular models, instructional design, and teachers' pedagogical knowledge, often treating policy as a stable backdrop rather than an active social process. This perspective risks obscuring the ways in which integrated STEM is shaped by national agendas, institutional histories, resource conditions, professional cultures, and local interpretations. As a result, gaps persist between discursive policy intention and classroom practice, which are frequently framed as problems of implementation rather than as features of policy work itself. This concept note argues for a conceptual shift of integrated STEM education as a policy enactment process. This implies that integrated STEM is framed not as a policy to be implemented but enacted through complex interactions among policy actors, texts, and contexts. Drawing on

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policy sociology, particularly the policy enactment framework advanced by Ball et al. (2012), this paper conceptualizes integrated STEM as a dynamic, socially mediated process. Policy enactment foregrounds the argument that policies are not simply delivered from the top down. Rather, they are interpreted and translated through sensemaking, negotiation, and recontextualization of policy actors within specific material and discursive conditions.

STEM integration as a policy problem

STEM integration has emerged as a prominent policy response to concerns about economic competitiveness, technological advancement, and workforce preparedness. From this perspective, integrated STEM policy is a form of policy work shaped by how policy discourses, institutional priorities, and contextual conditions interact in practice. While policy texts often frame integrated STEM as a coherent solution to national development agenda, including innovation, workforce readiness, and economic development (Department of Education, 2023a; National Economic & Development Authority, 2023), this framing obscures the complexities involved in translating this national agenda into institutional and teacher practice.

From a policy perspective, STEM integration is problematized by its conceptual ambiguity. The literature presents multiple, often competing definitions of integration, ranging from multidisciplinary connections to fully transdisciplinary approaches, resulting in a lack of clarity about what integration entails in practice (Margot & Kettler, 2019; Martín-Páez et al., 2019; Roehrig et al., 2021). This ambiguity is reproduced in policy texts, which frequently promote STEM integration as a policy solution without specifying its operational boundaries. Consequently, schools are left to interpret and define integration within their own contexts, transforming a policy directive into a site of negotiation rather than implementation.

Moreover, STEM integration becomes a policy problem because it is mediated by contextual conditions. The enactment of integration is shaped by material resources, professional expertise, geographic location, and access to external networks (Suriyabutr & Williams, 2021; Zhang & Livingstone, 2019; Zhang & Shen, 2015). Schools with greater access to infrastructure, digital technologies, and industry partnerships are positioned to enact more expansive forms of integration, while those in resource-constrained contexts must adapt integration to what is feasible (Eppley, 2017; Govender, 2025). As such, policy aspirations for coherent STEM outcomes are undermined by uneven conditions of enactment, producing differentiated outcomes.

The problem is further compounded by tensions between policy goals and institutional realities. Policies often position STEM integration as a means of developing 21st-century skills and preparing students' future careers to drive national development (Department of Education, 2023b; National Economic and Development Authority, 2023; Second Congressional Commission on Education, 2022). However, these goals must be reconciled with existing accountability structures, disciplinary traditions, and assessment regimes, which may privilege content mastery over interdisciplinary practices. This creates misalignment between what policy promotes and what schools are structurally able to prioritize, reinforcing the need for negotiation at the level of practice.

At the same time, within implementing these policy priorities in schools is not straightforward. Teachers and school leaders must interpret and translate national development imperatives within the practical constraints of curriculum structures, disciplinary traditions, performance standards, and local resources. Even as teachers re-contextualized lessons, re-strategized pedagogies, and worked on collaborative assessments to enable interdisciplinary learning, their work carried the imprint of policy expectations about innovation, productivity, and future-readiness. These processes illustrate what Ball et al. (2012) describe as 'policy translation', where abstract policy ambitions are reassembled into locally workable practices.

As a result, STEM integration emerges as a policy problem rather than a clearly defined instructional model. Schools are tasked with responding to broad policy goals without detailed implementation frameworks. They translate them into feasible curriculum enactment, while simultaneously negotiating the tensions and limits that arise when policy goals meet local realities (Chrysochou et al., 2025). This policy ambiguity shifts the responsibility for defining and enacting STEM integration onto policy actors within schools (Thompson et al., 2022). Teachers and school leaders must therefore interpret policy intentions and translate them into workable practices within their specific institutional and contextual conditions.

Rethinking STEM Integration as a Policy Enactment

Although integrated STEM has attracted increasing scholarly attention over the past decade, the literature remains largely focused on STEM integration as a pedagogical issue, with a dominant focus on instructional strategies, classroom practices, and teacher professional development (Roehrig et al., 2021; Tytler et al., 2021). While this work has generated important insights, its pedagogical emphasis has tended to marginalize analysis of broader policy structures, system-level conditions, and contextual realities that shape the implementation of integrated STEM in schools. As a result, STEM integration is often examined in isolation from the policy processes through which it is framed, interpreted, and enacted. This gap points to the need to analyze integrated STEM as a form of policy enactment, situated within broader educational and institutional dynamics rather than solely within classroom practice.

While integrated STEM research has strong design and instructional practice traditions, it has comparatively limited theorization of integrated STEM as policy work (interpretation, translation, recontextualization across levels). Empirical studies also indicate that integrated STEM enactment is under-analyzed compared with pedagogical design and outcomes research (Anderson et al., 2022; Tytler et al., 2021; Zhang & Ma, 2023). For example, in a study of a STEM Innovation Program in partnership with a private corporation in the Philippines, Paderna and Monterola (2021) identified several variables that must be present and redesigned to ensure the program's scalability and sustainability. This gap signals an opportunity for reframing integrated STEM as a policy enactment, which can provide the analytical framing to analyze the social production of 'integration' at the point where policy meets practice.

Accordingly, there is a need for empirically grounded and theoretically robust studies that explain why integrated STEM assumes different forms across contexts, even when schools operate under the same policy framework. For example, examining teacher practice across specialized science high schools or schools operating under a special science curriculum in rural and remote areas would provide empirical data on this gap. School sites will be purposively selected to capture contextual variation in rurality, institutional resources, and professional culture. Addressing this gap necessitates answering the following research questions:

1. How is integrated STEM education framed within national and institutional system-level policy texts?
2. What contextual conditions enable or constrain particular enactments of integrated STEM?

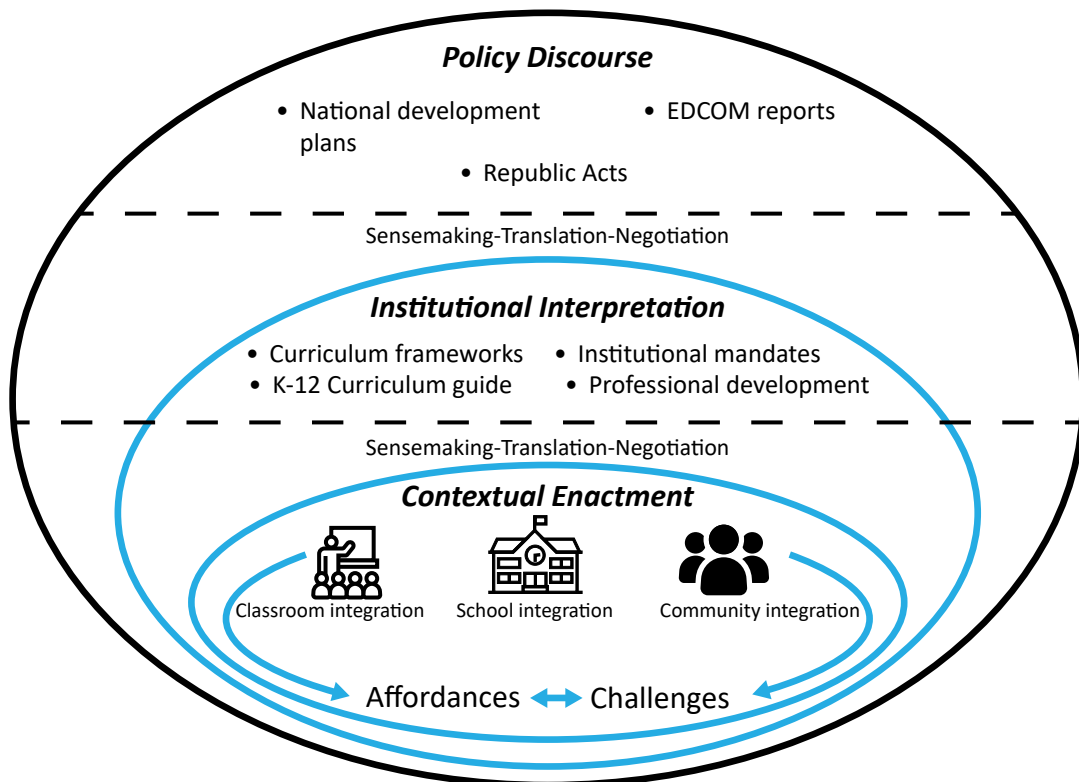
These questions are important because integrated STEM is not a singular or stable practice but one shaped by policy discourse and enacted under diverse contextual conditions. Examining how integrated STEM is framed in national and system-level policy texts reveals how particular problems, purposes, and forms of integration are defined and legitimized, shaping what schools are expected to do. Specific policy texts could be analyzed from the national level down to institutional policies, such as the *Philippine Development Plan*, *EDCOM II report*, *DepEd's K-12 Curriculum Framework*, *Shaping Paper and Curriculum Guides*, school's vision and mission, school-based implementation guidelines on STEM integration, and similar documents explicating STEM integration. However, policy intentions alone cannot explain the variation observed in practice. Investigating the contextual conditions that enable or constrain enactment highlights how professional cultures, material resources, organizational structures, and local circumstances mediate policy in practice (Ball et al., 2012). These contextual dynamics may be explored through a qualitative case study approach to capture how STEM policies are interpreted and enacted across educational settings (Stake, 1995; Yin, 2018). Together, these questions necessitate a policy enactment perspective, which recognizes that integrated STEM is not simply implemented, but interpreted, translated, and reshaped by actors operating within situated institutional contexts.

Integrated STEM as a policy enactment conceptual framework

Reframing integrated STEM through Ball et al.'s (2012) policy enactment allows analysis to move beyond evaluating whether 'integration' works towards how integration is produced and reshaped across institutional contexts. While integrated STEM remains a prominent policy reform, its implementation is often uneven, shaped by teachers' conceptual uncertainty and contextual constraints related to structural properties, scalability, and accountability systems that reconfigure policy aspirations in practice (Paderna & Monterola, 2021; Readette et al., 2025; Vasiliene-Vasiliauskiene et al., 2020). Framing integrated STEM through this framework, therefore, requires viewing it into three levels of enactment: policy discourse, institutional interpretation, and contextual enactment. Figure 1 shows this conceptualization.

Figure 1

Integrated STEM as a policy enactment conceptual framework



At the level of policy discourse, national and global narratives position STEM education as a key driver of economic growth, national innovation, and workforce preparedness (Morales et al., 2022; Mudaly & Chirikure, 2023). These narratives construct policy problems such as national competitiveness and skills shortages, and legitimate STEM education as

a policy response (Science and Technology Scholarship Act, 1994; Second Congressional Commission on Education (EDCOM II) Act, 2022). These policy texts at the national level may be examined through discourse analysis, exploring the discursive messages implied by policies (Bacchi, 2000). As they are incorporated into national education systems, shifts in educational priorities may be observed, positioning STEM skills as essential to social and economic development. At the level of national strategies and curriculum frameworks, integration is typically positioned as a way to make learning more authentic, connected to real-world problems, and aligned with interdisciplinary work practices (Department of Education, 2016, 2023b). Within this framing, STEM integration is closely linked with 21st-century skills, innovation capacity, and employability, shaping expectations placed on schools (Camilli & Hira, 2019).

However, as integrated STEM moves from policy texts into school systems and classrooms, it does not arrive as a single stable model. Instead, it travels as a broad policy signifier—flexible enough to be adopted across contexts, yet vague enough that its meaning and form are re-specified locally (Svendsen et al., 2025). At this stage of institutional interpretation, schools act as key sites where policy expectations are converted into organizational priorities and curriculum initiatives (Montgomery et al., 2016). This process is operationalized through institutional-level policy texts. Through these texts, school leaders and teachers negotiate the meaning of STEM integration and legitimize in practice specific enactments through professional development and recommended pedagogical approaches such as project-based learning, design thinking, and engineering design process (Erenea & Sarmiento, 2025; Martín-Páez et al., 2019; Watkins, 2023).

The translation of policy expectations is operationalized through an array of policy texts, including curriculum frameworks, institutional mandates, and leadership directives (Ball, 1993). These texts do not prescribe fixed practices but provide symbolic and practical resources that structure how STEM integration is represented, idealized, and communicated within schools (Ball et al., 2012). These texts may be ‘intertextually’ analyzed with each other to demonstrate competing or supporting discourses.

To corroborate the findings from textual analysis, institutional enactment can be observed through interviews with teachers and leaders, where such enactment is shaped by material and situated conditions. This condition is mediated by curriculum structures, staffing configurations, availability of professional developments, access to resources, and external linkages. This material and situated conditions shape which forms of STEM integration are feasible and sustainable, influencing how policy expectations are prioritized and enacted in practice.

Within schools, professional cultures and teachers’ expertise and beliefs play a central role in legitimizing particular enactments of STEM integration (Biesta et al., 2015). Professional development, training programs, and suggested pedagogical approaches function as mechanisms through which certain interpretations of ‘integration’ are normalized. This

professional context influences whose knowledge counts, and which practices are affirmed as appropriate enactments of policy (Ball et al., 2012). At this level of enactment, policy dynamics can be understood through multiple and overlapping contexts identified by Ball et al. (2012), where schools operate as key sites where policy meanings are interpreted and negotiated. School leaders and teachers, therefore, engage in sensemaking work, interpreting what STEM integration means in relation to local priorities, existing curricula, and professional identities (Holmes et al., 2021; Watkins, 2023). These interpretations shape how policy expectations are understood and whether integration is framed as interdisciplinary curriculum design, project-based learning, or disciplinary collaboration. Taken together, these contexts illustrate how schools do not simply implement STEM integration policy, but actively enact it through situated processes of interpretation, translation, and institutional embedding.

Finally, at the level of contextual enactment, STEM integration is shaped through the interaction of multiple contextual domains that interact and reconfigure STEM integration practices. For example, future study can examine the dynamics of professional culture (teacher expertise and collegial collaboration) and material resources (infrastructure, funding, facilities) shaping which forms of integration are feasible in practice. In addition, situated conditions (rurality and student demographics) and the availability of external partnerships (local industries and agencies) may influence the particular configuration of integration that can be pursued. These interacting contexts can be observed in how policy aspirations are translated into the everyday work of teachers, showing the types of enactment that can be observed across three sites of practice: classroom, school, and community.



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