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DIGITAL ADOPTION STRATEGIES EMPLOYED BY KEY STAGE 2 SCIENCE TEACHERS: IMPACT ON LEARNING PERFORMANCE IN THE PROVINCE OF ALBAY

IVEE ANN B. MATIAS
Master Teacher I
Bogtong Integrated School
ivee.matias@deped.gov.ph

ABSTRACT

Digital transformation is reshaping science instruction, where visualization and interactivity are vital for learning. This study evaluated digital adoption strategies among Key Stage 2 science teachers in the Schools Division Offices of Legazpi, Ligao, and Tabaco in Albay Province. Anchored in the Digital Pedagogical Transformation Theory (DPTT) and guided by the Context-Input-Process-Product (CIPP) evaluation model, it examined tool utilization, integration strategies, and their impact on instructional quality and student learning. Employing a descriptive-correlational design, the study surveyed science teachers to analyze the relationship between the availability of digital tools and their pedagogical application. Findings reveal that adoption has reached a significant level, with teachers frequently using accessible tools such as presentation software and video platforms to improve lesson clarity and student motivation. While teachers perceive positive impacts on student attitudes, statistical analyses show no significant correlation between tool use and advanced integration strategies, indicating that current practices emphasize efficiency and delivery rather than transformative knowledge construction. The study concludes by recommending the implementation of a Continuous Improvement Plan (CIP), "Project DPTT-Scie," designed to

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bridge gaps between digital access and pedagogical efficacy through targeted professional development, equitable infrastructure support, and instructional innovation to advance meaningful digital integration in science education.

Keywords: *Digital Adoption, Key Stage 2 Science, CIPP Evaluation Model, DPTT, Continuous Improvement Plan*

INTRODUCTION

Background of the Study

Education worldwide has undergone a profound reshaping, with digital technology shifting from a supplementary tool to an essential component of classroom instruction. Global frameworks explicitly acknowledge this paradigm shift; both the UN's Sustainable Development Goals and UNESCO policy frameworks have polished digital readiness, from student competencies to school infrastructure, as indispensable requirements for preparing learners for modern employment and civic life (UN DESA, 2024; UNESCO, 2023). However, translating these aspirations into classroom realities remains deeply uneven, as nearly half of the world's schools still lack basic computer or internet access. Research makes clear that simply equipping classrooms with devices is insufficient; what matters most is educators' capacity to weave technology meaningfully into subject-specific instruction, which is an integration that goes beyond using gadgets as novelty items (Mishra & Koehler, 2006; Scherer et al., 2021). Globally, the persistence of infrastructural deficits, insufficient training, and the stark gap between aspirational policies and actual classroom implementation continue to hinder meaningful educational advancement (Boelens et al., 2023; Crompton et al., 2021).

In the Philippines, the push for digital literacy is embedded in major educational reforms, such as the MATATAG curriculum, yet severe infrastructural and economic barriers persist. Data from Philippine education surveys paint a stark picture: a large majority of families, with over 80% remain without home internet access, while elementary schools report device scarcity so severe that a single computer may serve up to 19 students (Barrot et al., 2021; Baticulon et al., 2021). Philippine performance data reveal a persistent educational crisis: approximately nine in ten children fail to read with comprehension by age 10, and national results in international science assessments such as TIMSS and PISA continue to fall well below global averages (Albert et al., 2023; Mullis et al., 2023; OECD, 2022; Toquero, 2021; World Bank, 2023). These national challenges are acutely felt in the Bicol Region, specifically within Albay Province. While local education officials actively pursue quality management, schools in Albay struggle with significant infrastructure constraints, as educators report a lack of teaching materials, unreliable internet connectivity, and insufficient administrative support for digital initiatives (Rasmitadila et al., 2021; Turnbull et al., 2021).

While the national and global literature extensively covers the barriers to digital education, there remains a critical gap in empirical evidence on how these challenges specifically affect Key Stage 2 (Grades 4 to 6) science instruction in resource-limited settings like Albay. At this cognitive stage, students transition from concrete to abstract reasoning—a phase where the MATATAG curriculum's focus on inquiry-based learning can be significantly enhanced by targeted digital technologies (Chou & Feng, 2021; Fidan & Tuncel, 2022; Piaget, 1972). Yet, the specific digital adoption strategies currently employed by these local educators are inadequately documented.

This study differentiates itself from broader national surveys by establishing direct, empirical links between context-specific classroom practices and quantifiable student learning outcomes. By documenting localized strategies, pedagogical methods, and contextual barriers, this research aims to close the implementation gap between high-level policy and grassroots reality, ultimately providing equity-focused, evidence-based frameworks to guide policymakers, school leaders, and teachers in elevating science learning within constrained environments.

MATERIALS AND METHODS

Research Methodology

This section explains the methodological approach used to investigate digital adoption strategies among Key Stage 2 science teachers in Albay Province. The methodology encompasses the selection of research design, development of instrumentation, data collection procedures, participant identification, sampling strategies, study site characteristics, ethical considerations, and analytical procedures. Each methodological decision reflects careful consideration of the study's objectives, theoretical framework, and practical constraints, ensuring that the investigation produces credible, rigorous, and actionable evidence regarding the integration of digital technology in science instruction.

Research Design

This study employed a quantitative descriptive-correlational research design. The descriptive component systematically documented the frequency of digital tool use and the extent to which specific integration strategies were applied across Key Stage 2 science classrooms. The correlational component examined statistical relationships among tool adoption, strategy implementation, perceived integration quality, and reported impact on student learning outcomes. This dual-focus design aligns with established methodological approaches for educational technology research and directly addresses the study's objectives concerning both current practice documentation and relationship testing (Crompton et al., 2021; Scherer et al., 2021).

Participants of the Study

The target population consisted of all Key Stage 2 science teachers employed in public elementary schools within the three Schools Division Offices of Albay Province: SDO Legazpi City (Congressional District 2), SDO Ligao City (Congressional District 3), and SDO Tabaco City (Congressional District 1). Inclusion required that teachers be officially assigned to Grades 4, 5, or 6 science during the 2025-2026 academic year. A total of 115 teachers participated: 42 from Legazpi, 28 from Ligao, and 45 from Tabaco across 42 schools.

Sampling Design

Total enumeration sampling was applied within purposively selected schools. Schools were stratified by enrollment size (large, medium, small) and geographic setting (urban, semi-urban, rural) to capture variation in infrastructure and resource conditions across the province.

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Within each selected school, all qualifying Key Stage 2 science teachers were invited to participate, constituting a census of the accessible population. This approach balances comprehensive coverage with analytical feasibility while supporting generalization to comparable contexts within Albay Province.

Research Instrument

A validated researcher-developed survey questionnaire served as the primary data collection tool. The instrument was structured into four integrated parts. Part 1 measured digital tool adoption frequency across 18 tools in six categories — virtual laboratories, learning management systems, interactive whiteboards, presentation software, video conferencing platforms, and educational video platforms — using a four-point Likert scale (4 = Always, 3 = Sometimes, 2 = Rarely, 1 = Never). Part 2 assessed integration strategy implementation across five approaches — mobile learning, blended classroom, gamified learning, collaborative tools, and formative assessment tools — using the same scale. Part 3 evaluated perceived quality of digital integration across 12 indicators in three dimensions using a four-point agreement scale (4 = Strongly Agree to 1 = Strongly Disagree). Part 4 measured perceived impact on student learning across knowledge, skills, and attitudes domains using the same agreement scale.

Validity of the Research Instrument

The instrument underwent expert validation by a panel of specialists in educational technology research and science education, who reviewed each item for content validity, clarity, and alignment with the study's theoretical framework grounded in TPACK and the

SAMR model. Comments and revisions were incorporated using the standard evaluation form. The instrument was subsequently pilot-tested with an independent group of Key Stage 2 science teachers to establish reliability and item clarity before final deployment.

Data Gathering Procedures

Formal endorsements were obtained from the Schools Division Superintendents of Legazpi, Ligao, and Tabaco prior to data collection, with coordination through Education Supervisors in Science and Division Research Coordinators. School heads of participating schools were informed of the study's objectives and schedule. The validated questionnaire was distributed in both printed and digital formats via Google Forms to accommodate varying levels of connectivity across school contexts. Informed consent was secured from all participants before administration. Data collection spanned four weeks during the second and third quarters of the 2025-2026 academic year, and the study adhered to DepEd Order No. 9, series of 2005 regarding research ethics, confidentiality, and voluntary participation.

Data Analysis

Objectives 1 and 2 were analyzed through descriptive statistics including weighted means and frequency counts. Kendall's Coefficient of Concordance (W) was employed for Objective 3 to examine the relationship between tool adoption and integration strategies, with statistical significance tested at the 0.05 level. Objectives 4 and 5 used weighted means to identify the highest and lowest rated quality and impact indicators across dimensions and divisions. Pearson's correlation coefficient (r) was used for Objective 6 to test the relationship between perceived quality and perceived learning impact, with significance determined by

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comparing the derived t-values with the critical value of 1.96 at the 5% significance level. Objective 7 synthesized all findings to develop a Continuous Improvement Plan grounded in the CIPP evaluation model.

RESULTS AND DISCUSSIONS

Summary of the Study

The study investigated the digital adoption strategies of Key Stage 2 science teachers across three Schools Division Offices in Albay Province — SDO Legazpi City, SDO Ligao City, and SDO Tabaco City — and their relationship to the perceived quality of integration and impact on student learning performance.

On digital tool adoption (Objective 1), presentation and design software earned the highest general category average across all divisions, driven almost entirely by Microsoft PowerPoint, which scored between 3.87 and 3.98 (Always) across the three SDOs. YouTube under educational video platforms similarly scored between 3.83 and 3.95 (Always). In contrast, virtual laboratories registered the lowest averages — 1.67 in Legazpi, 1.56 in Ligao, and 1.44 in Tabaco — all rated Never, reflecting a near-complete absence of science-specific simulation platforms. Overall general averages were 2.18 in Legazpi, 2.11 in Ligao, and 2.30 in Tabaco, all within the Rarely range. This pattern places current practice at the Substitution stage of the SAMR framework, where digital tools replace traditional methods without meaningful functional change.

On integration strategies (Objective 2), mobile learning posted the highest category averages across all divisions — 3.22 in Legazpi, 3.14 in Ligao, and 3.16 in Tabaco (Sometimes)

— driven primarily by laptop and computer use, which scored Always in all three SDOs. Face-to-face blended learning reached perfect or near-perfect scores (up to 4.00 in Ligao). By contrast, formative assessment tools registered the lowest category averages — 2.02 in Legazpi, 1.89 in Ligao, and 1.93 in Tabaco — all within the Rarely band. General strategy averages of 2.59 in Legazpi, 2.50 in Ligao, and 2.65 in Tabaco indicate that strategy use remains concentrated on convenience-driven approaches rather than inquiry-based or student-centered models.

Regarding the relationship between tools and strategies (Objective 3), Kendall's tau produced an r-value of 0.13 and a t-value of 0.27, both well below the critical value of 1.96 at the 5% level of significance. The null hypothesis was accepted, confirming no significant relationship between the digital tools teachers adopt and the strategies they employ. This reflects the TPACK gap between isolated technological knowledge and the integrated technological-pedagogical-content knowledge that purposeful classroom use requires — having tools does not equate to knowing how to connect them to specific learning goals.

On perceived quality of digital integration (Objective 4), all three divisions rated quality in the Strongly Agree range: Legazpi at 3.62, Ligao at 3.50, and Tabaco at 3.63. The highest indicator across divisions was making science lessons interactive, engaging, and student-centered under instructional delivery. The lowest indicators generally involved adaptive responsiveness to individual student needs, suggesting that while teachers perceive digital tools as enhancing engagement broadly, their capacity for personalized instruction remains limited.

On the impact of digital adoption on student learning (Objective 5), all three divisions also rated impact in the Strongly Agree range: Legazpi at 3.57, Ligao at 3.47, and Tabaco at 3.59. The strongest impacts were observed in the attitudes domain — particularly increased student motivation and self-directed learning — while data analysis and interpretation under skills development registered the lowest scores. This pattern indicates that digital integration most visibly builds student engagement and confidence rather than higher-order scientific thinking skills.

On the relationship between quality and impact (Objective 6), Pearson's r-value of 0.12 and a t-value of 0.18 fell far below the critical value of 1.96, leading to the acceptance of the null hypothesis. Despite both quality and impact being rated uniformly high, no statistically significant relationship was found between them. This disconnect reflects what the study identifies as a Perception-Practice Gap: teachers hold positive views of their digital practices and their outcomes, but these assessments appear to be evaluated through separate lenses — quality judged by tool functionality and lesson smoothness, impact judged by visible student enthusiasm — rather than as causally linked dimensions. Contextual factors including infrastructure variability, unreliable connectivity, and measurement limitations based on self-report also contribute to obscuring this relationship.

Insights

Across all six objectives, the data collectively trace a consistent pattern: digital adoption in Albay Province's Key Stage 2 science classrooms has reached a functional baseline, but it has not yet progressed toward transformative integration. Teachers use technology

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regularly and hold genuinely positive views of its value, yet the tools they choose and the strategies they employ remain anchored in convention. PowerPoint replaces the chalkboard; YouTube replaces the science textbook illustration; laptops enable the same lecture with a screen. Under the SAMR framework, this is Substitution and Augmentation — necessary first steps, but insufficient for the kind of learning the MATATAG science curriculum envisions.

The two absent correlations — between tools and strategies, and between quality and impact — are the study's most revealing findings. They show that access does not create alignment, and satisfaction does not reflect transformation. Teachers can be equipped with platforms and still not integrate them with strategic intent. They can rate both their practices and their students' growth as excellent and still be describing largely separate phenomena. The missing link in both cases is TPACK: the capacity to fuse tool knowledge with science-specific pedagogy in ways that make learning genuinely different and deeper.

The attitudinal gains documented in Objective 5 are worth noting. Teachers across all divisions report that students are more motivated, more curious, and more willing to collaborate when digital tools are used. These affective outcomes are real and significant — they lay the relational and motivational groundwork for deeper learning. The challenge is that motivation without accompanying cognitive depth leaves students engaged but not necessarily better equipped to think scientifically. The lowest-rated indicators in the skills domain — data analysis, interpretation, evidence-based reasoning — point to precisely the scientific competencies that the curriculum prioritizes and that current practices are not yet developing.

Contextual differences across the three SDOs are instructive. Tabaco consistently scores higher across tools, strategies, quality, and impact, suggesting that infrastructure advantages and stronger professional development create conditions where digital adoption edges closer to purposeful integration. Ligao consistently scores lowest, reflecting pronounced structural constraints. But the fact that neither the tools-strategies correlation nor the quality-impact correlation is significant in any division confirms that the gap between access and transformation is not primarily a hardware problem — it is a pedagogical and institutional one that transcends local conditions.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are advanced:

For Objective 1 (digital tool adoption), school divisions should expand professional development to include hands-on training on science-specific platforms, such as PhET Simulations, Labster, and Go-Lab, which are currently underutilized across all divisions. Awareness campaigns and mentoring by tech-savvy colleagues can lower the entry barrier to tools that directly support inquiry-based science learning aligned with MATATAG competencies.

For Objective 2 (integration strategies), the consistent absence of formative assessment tools across all SDOs calls for targeted training that moves beyond device use toward real-time learning monitoring. Teachers should be guided on embedding platforms like Kahoot, Quizizz, and Mentimeter into everyday lessons as feedback mechanisms rather than

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optional add-ons. Coaching on flipped learning approaches should also be prioritized as infrastructure permits.

For Objective 3 (tools-strategies relationship), since no significant correlation was found between digital tool adoption and integration strategies, future studies are recommended to examine correlations between teacher technology self-efficacy, the number of technology-specific training hours, and school ICT resource level and tool adoption to identify variables that more meaningfully predict strategic integration. The most actionable of these is self-efficacy: if confirmed to correlate positively, the recommended response is a peer-coaching program pairing teachers with experienced colleagues who model purposeful tool use in actual science lessons, gradually moving practice from Substitution toward Modification and Redefinition levels of the SAMR framework.

For Objective 4 (quality of integration), teachers should be supported in developing more differentiated evaluative frameworks for assessing their own integration quality — specifically distinguishing between tool accessibility and pedagogical effectiveness. Division supervisors should incorporate digital integration quality as a component of classroom observation tools, providing teachers with structured criteria for self-assessment.

For Objective 5 (impact on student learning), the prominence of attitudinal over cognitive impacts indicates the need for professional development that teaches teachers how to leverage digital tools for higher-order scientific thinking. Data logging tools, digital inquiry investigations, and collaborative sense-making platforms should be prioritized alongside motivational applications to ensure that engagement translates into measurable gains in scientific reasoning and skills.

For Objective 6 (quality-impact relationship), since quality perceptions and impact perceptions showed no significant relationship, future studies should examine whether teacher reflective practice frequency, instructional coaching participation rate, and curriculum alignment score correlate positively with quality learning outcomes. The most actionable starting point is teacher reflective practice: integrating a structured post-lesson reflection protocol into regular Learning Action Cell sessions — where teachers document the tool used, the lesson goal, and evidence of student learning — creates a routine that connects quality decisions to learning results and builds capacity for the Modification and Redefinition levels of SAMR over time.

For Objective 7 (Continuous Improvement Plan), the proposed Project DPTT-Scie should be implemented across all three SDOs with priority given to the three key priority areas: KPA 1 — Instructional Competence, elevating teachers from Basic Adopters to Transformative Integrators through monthly "Simulate and Solve" Learning Action Cells, a Peer Mentoring Program, and a Micro-Credential badge system; KPA 2 — Curriculum Delivery, transitioning lesson plans from teacher-centered presentations to student-centered knowledge construction through DLP Writeshops, demo teaching, student portfolio systems, and lesson study cycles; and KPA 3 — Learning Environment, ensuring equitable digital access through Project OFFLINE digital kits, Smart TV procurement via stakeholder linkages, mobile science

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labs, and Division Tech Hubs. Quarterly monitoring using the CIPP framework should track instructional competence, pedagogical transformation, and student learning outcomes.

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