

Beyond Digital Proficiency: Enablers of Teachers' Technology-Supported Action Research and Classroom Innovation in Philippine Basic Education

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Abstract

Philippine basic education has invested heavily in digital transformation, yet teachers' capacity to convert technology into research productivity and classroom innovation remains uneven, context-dependent, and undertheorized. This study examined the role of technology in strengthening teachers' action research practices by integrating two integrative frameworks developed for this study, the Technology-Integration Competence Theory (TICT) and the Action Research Digital Integration Theory (ARDIT), in Department of Education (DepEd) Region VIII, Philippines. Using an exploratory research design, data were collected from 211 basic education teachers from urban and rural schools during Academic Year 2025-2026 through a structured survey questionnaire and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) in WarpPLS, with the sample exceeding the G*Power minimum requirement of 119 respondents for the largest three-predictor equations (146 under a more conservative six-predictor specification). The measurement model demonstrated strong psychometric properties, with indicator loadings of 0.800 to 0.942, Cronbach's alpha of 0.875 to 0.950, composite reliability of 0.909 to 0.962, and AVE of 0.667 to 0.835, while the Fornell-Larcker criterion and HTMT ratios confirmed discriminant validity. Teachers reported highly positive perceptions across all eight constructs, with Technology Tools Proficiency obtaining the highest mean (4.84) and Data Accessibility the lowest (4.25). The structural model showed strong overall quality (Tenenhaus GoF = 0.617) and substantial explained variance for Digital Resource Utilization ($R^2 = 0.525$) and Technology-Based Classroom Innovation ($R^2 = 0.552$). Four of the seven hypothesized paths were supported: Ease of Use Perception ($\beta = 0.342$, $p < 0.001$)

and Technological Support Availability ($\beta = 0.384, p < 0.001$) significantly predicted Action Research Productivity, Technology-Enhanced Collaboration strongly predicted Digital Resource Utilization ($\beta = 0.725, p < 0.001$), and Data Accessibility strongly predicted Technology-Based Classroom Innovation ($\beta = 0.735, p < 0.001$). In contrast, Technology Tools Proficiency, Digital Resource Utilization, and Action Research Productivity showed no significant direct effects on their targeted outcomes. The findings indicate that technological competence alone is insufficient unless supported by user-friendly systems, institutional support, collaborative digital environments, and accessible research data infrastructures. The study contributes to the literature by empirically validating a unified TICT-ARDIT framework and by providing the evidence base for the Evidence-Driven Digital Innovation Action Cycle (EDDAC) Framework, a structured cycle of data collection, evaluation, and refinement of technology-enabled interventions designed to enhance teachers' research productivity and instructional innovation across the diverse urban and rural school contexts of the region and comparable developing-country education systems.

Keywords

Technology Integration, Action Research Productivity, Classroom Innovation, Teacher Research, PLS-SEM

1. Introduction

The integration of technology in education has reshaped instructional approaches, collaborative efforts, and professional development among educators, making a thorough exploration of technology's role in enhancing action research practices increasingly necessary. Action research empowers teachers to systematically assess and improve their teaching strategies using data-driven insights, yet persistent challenges inhibit the effective use of technology in supporting teachers through this process, including inadequate training, limited access to technological resources, and fragmented application of research findings (Kiong, 2023; Selialia & Kurata, 2023). Reports from the Philippine Department of Education (DepEd) underscore that despite national digital transformation initiatives, professional development programs often overlook research-oriented applications of digital skills (Topalska, 2024), while many public schools, particularly in rural areas, lack the infrastructure and institutional support required for technology-assisted research (Cheng & Parker, 2023; Ohei et al., 2023). Even when action research is completed, fragmented collaboration mechanisms and the absence of user-friendly systems hinder the translation of findings into classroom practice (Adipat et al., 2023).

Two integrative frameworks developed for this study provide structured perspectives for addressing these hurdles. The Technology-Integration Competence Theory (TICT) emphasizes teachers' competence in using technology for data collection, analysis, and presentation, expressed through the constructs of Technol-

ogy Tools Proficiency (TTP), Ease of Use Perception (EUP), Technological Support Availability (TSA), and Action Research Productivity (ARP). The Action Research Digital Integration Theory (ARDIT) explains how digital tools bridge research outcomes and classroom innovation through Digital Resource Utilization (DRU), Technology-Enhanced Collaboration (TEC), Data Accessibility (DA), and Technology-Based Classroom Innovation (TBCI) (Alrwaished, 2024; Adipat et al., 2023).

This study assessed the role of technology in supporting action research practices using a unified TICT-ARDIT framework among basic education teachers in DepEd Region VIII during Academic Year 2025-2026, as a basis for an Evidence-Driven Digital Innovation Action Cycle (EDDAC) Framework. Specifically, it 1) described the demographic profile of teacher-respondents; 2) measured perceptions of the eight framework constructs; 3) evaluated the reliability and validity of the measurement model; 4) assessed the structural model; and 5) tested seven hypothesized paths using PLS-SEM, a method well suited for complex latent-variable models with moderate sample sizes in educational settings (Hair et al., 2019; Wijaya et al., 2022).

2. Literature Review and Hypothesis Development

2.1. Theoretical Background

TICT holds that teachers' competence in using technology enhances their ability to engage effectively in action research by equipping them with the skills to utilize digital tools across the research cycle, with usability perceptions and institutional support conditioning whether competence converts into productive research output (Peng et al., 2023; Habibi et al., 2022). ARDIT foregrounds technology's integrative role in supporting collaboration, resource optimization, and the effective translation of research findings into classroom practices, positioning collaborative digital environments and accessible data infrastructures as the channels through which research outputs become instructional innovation (Adipat et al., 2023; Martinović & Milner-Bolotin, 2024). Empirical work on technology integration in education supports both perspectives while noting that effects are context-dependent, shaped by school socioeconomic conditions, infrastructure, and teacher readiness (Cheng & Parker, 2023; Farias-Gaytan et al., 2021; Penu et al., 2024).

TICT and ARDIT are not previously established named theories; they are integrative frameworks developed for this study to organize the technology-enabled action research process, and their sources and construct boundaries are therefore specified here. TICT synthesizes the perceived ease-of-use mechanism of the Technology Acceptance Model (Davis, 1989), the teacher-knowledge perspective of Technological Pedagogical Content Knowledge (Mishra & Koehler, 2006), and the technology-integration literature on institutional support conditions (Peng et al., 2023; Habibi et al., 2022). Its boundary is the individual teacher-competence layer: it covers teachers' proficiency with digital tools (TTP), their usability perceptions (EUP), and the institutional support available to them (TSA) as anteced-

ents of a single outcome, Action Research Productivity (ARP), and it makes no claims about classroom-level change. ARDIT extends the same literature to the integration layer that links completed research to practice: it covers teachers' use of digital resources (DRU), technology-mediated collaboration (TEC), and access to research and instructional data (DA) as antecedents of Technology-Based Classroom Innovation (TBCI). The bridging path from ARP to TBCI (H7) is the only cross-framework relationship, so the unified TICT-ARDIT model remains fully specified, and falsifiable, at the level of its eight constructs and seven hypothesized paths.

2.2. Hypotheses

Seven hypotheses were formulated and tested at the 0.05 level of significance. From TICT: technology tools proficiency positively predicts action research productivity (H1); ease of use perception positively predicts action research productivity (H2); and technological support availability positively predicts action research productivity (H3). From ARDIT: digital resource utilization positively predicts technology-based classroom innovation (H4); technology-enhanced collaboration positively predicts digital resource utilization (H5); and data accessibility positively predicts technology-based classroom innovation (H6). Bridging the two frameworks, action research productivity positively predicts technology-based classroom innovation (H7).

3. Methodology

3.1. Research Design

An exploratory research design was utilized, which is particularly effective for investigating relatively under-explored phenomena where variables and relationships are not yet fully established (Henriques et al., 2021; Dias-Trindade et al., 2023). The design suited the evolving state of technology-integrated action research in basic education and accommodated the diverse technological contexts of schools, variations in teacher readiness, and differential access to ICT resources (Berrocoso et al., 2021; Telenchana et al., 2024). PLS-SEM in WarpPLS served as the analytical method, enabling concurrent assessment of the measurement and structural models across the eight latent constructs (Hair et al., 2019; Sarstedt et al., 2022).

3.2. Respondents and Sampling

The respondents were basic education teachers employed under DepEd Region VIII during Academic Year 2025-2026, drawn from both urban and rural schools representing diverse levels of ICT access, teaching experience, grade levels, and technology-related training (González-Zamar et al., 2020; Nunes & Malagri, 2024). Purposive sampling ensured inclusion of teachers with varying research exposure, technological proficiency, and institutional contexts (Farias-Gaytan et al., 2021). Sample size was determined a priori using G*Power 3.1.9.7 (F tests, lin-

ear multiple regression: fixed model, R^2 deviation from zero; effect size $f^2 = 0.15$, $\alpha = 0.05$, power = 0.95). With three predictors in the largest structural equations (TTP, EUP, and TSA predicting ARP; DRU, DA, and ARP predicting TBCI), this setup requires a minimum of 119 respondents; the figure of 146 originally adopted corresponds to a more conservative six-predictor specification and was retained as the recruitment floor, with a 20% buffer targeting 175 - 200 participants. After data cleansing excluded six cases, 211 valid responses were retained, exceeding both thresholds. Most respondents were aged 30 - 39 years (57%) and female (83%); 44% were Master Teachers; 88% taught in rural schools; and 64% handled elementary levels. Notably, 32% reported that technological resources were rarely accessible.

The sampling frame consisted of teachers currently employed in public elementary and secondary schools under the DepEd Region VIII schools divisions during Academic Year 2025-2026. Following division- and school-level authorization, recruitment proceeded through school heads and ICT coordinators, who disseminated the questionnaire to eligible teachers after the orientation sessions described in Section 3.4. Eligibility required current employment as a basic education teacher in the region and provision of written informed consent; non-teaching personnel and pre-service teachers were excluded. Because dissemination was school-mediated, the number of invited teachers per school was not centrally logged; the composition of the retained sample is therefore reported to delimit the scope of inference. Of the 217 completed questionnaires retrieved, 211 were retained after data cleansing (Section 3.5). Among the retained respondents, 184 (87.2%) taught in rural schools and 24 (11.4%) in urban schools, with three respondents not reporting school location, so the findings generalize most directly to the predominantly rural school contexts of the region.

3.3. Instrument

A structured survey questionnaire operationalized the eight constructs of the unified TICT-ARDIT framework, with five reflective items per construct rated on a five-point Likert scale: Technology Tools Proficiency, Ease of Use Perception, Technological Support Availability, and Action Research Productivity from TICT, and Digital Resource Utilization, Technology-Enhanced Collaboration, Data Accessibility, and Technology-Based Classroom Innovation from ARDIT. Items were refined for the DepEd context and grounded in the literature on technology integration and teacher research practices.

The items were researcher-developed for this study, grounded in the constructs of the Technology Acceptance Model (Davis, 1989), the TPACK framework (Mishra & Koehler, 2006), and prior technology-integration instruments (Peng et al., 2023; Habibi et al., 2022; Wijaya et al., 2022), and contextualized to the platforms and workflows of Philippine public basic education (e.g., DepEd Commons, the DepEd Learning Resource Portal, DepEd learning management systems, and Google Workspace tools). Content validation proceeded through review by a

panel of experts in educational technology, teacher education, and research methodology, who evaluated construct coverage, item clarity, and contextual fit; items were refined based on their feedback before administration. The complete 40-item instrument, organized by construct, is provided in Appendix A so that the measurement content of the eight reflective constructs can be independently assessed.

3.4. Data Collection and Ethical Considerations

Following institutional authorization through a formal transmittal letter, orientation sessions explained the study's purpose, the voluntary nature of participation, the confidentiality of responses, and the right to withdraw at any time. Written informed consent was obtained from all participants before questionnaires were administered. Completed instruments were retrieved, reviewed for completeness, anonymized, and coded prior to analysis.

3.5. Data Analysis

The dataset underwent rigorous cleansing. Of the 217 completed questionnaires retrieved, six cases (2.8%) were excluded under the following pre-specified criteria: 1) incompleteness, defined as missing responses on more than 10% of the 40 construct items; 2) duplicate submission, identified through identical 40-item response vectors combined with matching demographic profiles; 3) low variability, defined as zero variance (straight-lining) across all construct items; and 4) failed sincerity screening, operationalized through logical-consistency checks between demographic filter questions and substantive responses. Because the 211 retained cases contained no missing construct responses, no imputation was required, and all analyses were conducted on complete data. Frequency counts and percentages profiled the respondents, and weighted means summarized construct perceptions. PLS-SEM evaluated indicator loadings, Cronbach's alpha, composite reliability, and AVE for the measurement model, discriminant validity through the Fornell-Larcker criterion and HTMT ratios (Henseler et al., 2014), and model fit and quality indices, R^2 , full collinearity VIF, Q^2 , path coefficients, and effect sizes for the structural model (Kock, 2020; Hair et al., 2019, 2021).

All models were estimated in WarpPLS with the following settings, reported here to permit exact reproduction: outer (measurement) model weights were obtained in Mode A using the PLS Regression outer algorithm; the inner (structural) model was estimated with the program's default nonlinear Warp3 algorithm, which fits S-shaped functions to the relationships among latent variable scores; standard errors and p -values were obtained with the default Stable3 method; and all hypothesis tests were one-tailed at $\alpha = 0.05$, consistent with the directional hypotheses (Kock, 2020). All estimation runs used the full set of 211 retained cases.

4. Results

4.1. Descriptive Results

Table 1 summarizes the respondents' perceptions of the eight constructs, all in-

terpreted as Strongly Agree with means from 4.25 to 4.84. Technology Tools Proficiency obtained the highest mean (4.84), reflecting strong confidence in using digital tools for action research, followed by Technological Support Availability (4.71) and Technology-Enhanced Collaboration (4.59). Data Accessibility received the lowest mean (4.25), pointing to digital infrastructure and data access as the relative weak point across urban and rural schools.

Table 1. Overall summary perception of the constructs in the model.

Construct	Mean	SD	Description
1. Technology Tools Proficiency (TTP)	4.84	0.51	Strongly Agree
2. Ease of Use Perception (EUP)	4.58	0.59	Strongly Agree
3. Technological Support Availability (TSA)	4.71	0.55	Strongly Agree
4. Action Research Productivity (ARP)	4.49	0.64	Strongly Agree
5. Digital Resource Utilization (DRU)	4.41	0.62	Strongly Agree
6. Technology-Enhanced Collaboration (TEC)	4.59	0.63	Strongly Agree
7. Data Accessibility (DA)	4.25	0.61	Strongly Agree
8. Technology-Based Classroom Innovation (TBCI)	4.45	0.68	Strongly Agree

4.2. Measurement Model

Table 2 presents the indicator loadings, reliability, and convergent-validity results. All loadings exceeded 0.70, ranging from 0.800 (DA1) to 0.942 (TEC3); Cronbach's alpha ranged from 0.875 to 0.950, composite reliability from 0.909 to 0.962, and AVE from 0.667 to 0.835, confirming strong measurement properties across all eight constructs (Hair et al., 2019, 2021).

Table 2. Indicator loadings, reliability, and convergent validity.

Construct	Items (loading range)	α	CR	AVE
Technology Tools Proficiency (TTP)	TTP1-TTP5 (0.880 - 0.936)	0.948	0.960	0.828
Ease of Use Perception (EUP)	EUP1-EUP5 (0.836 - 0.900)	0.921	0.940	0.759
Technological Support Availability (TSA)	TSA1-TSA5 (0.835 - 0.907)	0.921	0.941	0.762
Action Research Productivity (ARP)	ARP1-ARP5 (0.875 - 0.938)	0.948	0.960	0.829
Digital Resource Utilization (DRU)	DRU1-DRU5 (0.865 - 0.896)	0.926	0.944	0.773
Technology-Enhanced Collaboration (TEC)	TEC1-TEC5 (0.889 - 0.942)	0.950	0.962	0.835
Data Accessibility (DA)	DA1-DA5 (0.800 - 0.855)	0.875	0.909	0.667
Technology-Based Classroom Innovation (TBCI)	TBCI1-TBCI5 (0.854 - 0.915)	0.933	0.949	0.790

Table 3 presents the Fornell-Larcker results: the square roots of AVE on the diagonal (0.817 to 0.914) exceeded all corresponding inter-construct correlations, the highest being 0.784 between Action Research Productivity and Digital Resource Utilization. **Table 4** presents the HTMT ratios, which ranged from 0.038 to 0.837 and remained below the 0.85/0.90 thresholds, with the highest ratio between Technology Tools Proficiency and Technological Support Availability (0.833) and very low ratios involving Data Accessibility and Technology-Based Classroom Innovation, confirming that the constructs are empirically distinct (Henseler et al., 2014).

Table 3. Discriminant validity using the Fornell-Larcker criterion (square roots of AVE on the diagonal).

Construct	1	2	3	4	5	6	7	8
1. TTP	(0.910)	0.674	0.778	0.508	0.440	0.505	0.028	-0.003
2. EUP	0.674	(0.871)	0.735	0.561	0.533	0.550	0.029	-0.027
3. TSA	0.778	0.735	(0.873)	0.570	0.469	0.509	0.090	0.016
4. ARP	0.508	0.561	0.570	(0.910)	0.784	0.641	-0.069	-0.119
5. DRU	0.440	0.533	0.469	0.784	(0.879)	0.716	-0.111	-0.185
6. TEC	0.505	0.550	0.509	0.641	0.716	(0.914)	-0.057	-0.142
7. DA	0.028	0.029	0.090	-0.069	-0.111	-0.057	(0.817)	0.662
8. TBCI	-0.003	-0.027	0.016	-0.119	-0.185	-0.142	0.662	(0.889)

Table 4. Discriminant validity using the HTMT ratio of correlations.

Construct	1	2	3	4	5	6	7
2. EUP	0.722						
3. TSA	0.833	0.799					
4. ARP	0.537	0.601	0.610				
5. DRU	0.469	0.577	0.508	0.837			
6. TEC	0.532	0.588	0.545	0.675	0.763		
7. DA	0.083	0.067	0.110	0.085	0.129	0.081	
8. TBCI	0.038	0.053	0.051	0.127	0.199	0.151	0.734

4.3. Structural Model

Table 5 presents the model-fit and quality indices. The Average Path Coefficient (0.343), Average R-Squared (0.488), and Average Adjusted R-Squared (0.482) were significant at $p < 0.001$; AVIF (2.704) and AFVIF (2.640) were within acceptable limits; and the Tenenhaus GoF of 0.617 indicated large combined explanatory performance. The SPR, RSCR, SSR, and NLBCDR values satisfied their respective criteria (Kock, 2020).

Table 5. Model fit and quality indices.

Index	Value	Criterion
Average Path Coefficient (APC)	0.343, $p < 0.001$	$p < 0.05$
Average R-Squared (ARS)	0.488, $p < 0.001$	$p < 0.05$
Average Adjusted R-Squared (AARS)	0.482, $p < 0.001$	$p < 0.05$
Average Block VIF (AVIF)	2.704	≤ 5 , ideally ≤ 3.3
Average Full Collinearity VIF (AFVIF)	2.640	≤ 5 , ideally ≤ 3.3
Tenenhous GoF	0.617	Small ≥ 0.10 ; medium ≥ 0.25 ; large ≥ 0.36
Sympson's Paradox Ratio (SPR)	0.714	≥ 0.70 , ideally = 1.00
R-Squared Contribution Ratio (RSCR)	0.966	≥ 0.90 , ideally = 1.00
Statistical Suppression Ratio (SSR)	1.000	≥ 0.70
Nonlinear Bivariate Causality Direction Ratio (NLBCDR)	0.929	≥ 0.70

Table 6 shows substantial explanatory and predictive performance: the model explained 38.7% of the variance in Action Research Productivity ($Q^2 = 0.390$), 52.5% in Digital Resource Utilization ($Q^2 = 0.523$), and 55.2% in Technology-Based Classroom Innovation ($Q^2 = 0.570$). Full collinearity VIF values (1.833 to 3.357) remained below 5, confirming construct independence (Wijaya et al., 2022; Mattos et al., 2022).

Table 6. Coefficient of determination, full collinearity VIF, and predictive relevance.

Endogenous construct	R ²	Full collinearity VIF	Q ²
Action Research Productivity (ARP)	0.387	3.039	0.390
Digital Resource Utilization (DRU)	0.525	3.357	0.523
Technology-Based Classroom Innovation (TBCI)	0.552	1.833	0.570

Because the inner model was estimated with the nonlinear Warp3 algorithm (Section 3.5), the R^2 values in **Table 6** reflect the explanatory power of the warped (S-shaped) relationships; they are therefore not recoverable from the linear identity $R^2 = \Sigma(\beta \times r)$ applied to the linear inter-construct correlations of **Table 3**, and the coefficients in **Table 7** are standardized coefficients of the warped predictors rather than linear regression weights. As a robustness check, re-estimating the model with the linear PLS algorithm on the final dataset yielded R^2 values of 0.366 for Action Research Productivity, 0.507 for Digital Resource Utilization, and 0.453 for Technology-Based Classroom Innovation, and produced identical hypothesis decisions: the same four paths (EUP $\rightarrow$ ARP, TSA $\rightarrow$ ARP, TEC $\rightarrow$ DRU, and DA $\rightarrow$ TBCI) were supported and the same three were not.

4.4. Hypothesis Testing

Table 7 summarizes the results of the seven hypotheses. Four paths were sup-

ported: Ease of Use Perception ($\beta = 0.342$, $p < 0.001$, $f^2 = 0.202$) and Technological Support Availability ($\beta = 0.384$, $p < 0.001$, $f^2 = 0.229$) significantly predicted Action Research Productivity with medium effect sizes, while Technology-Enhanced Collaboration predicted Digital Resource Utilization ($\beta = 0.725$, $p < 0.001$, $f^2 = 0.525$) and Data Accessibility predicted Technology-Based Classroom Innovation ($\beta = 0.735$, $p < 0.001$, $f^2 = 0.549$) with large effect sizes. In contrast, Technology Tools Proficiency ($\beta = -0.085$, $p = 0.106$), Digital Resource Utilization ($\beta = -0.064$, $p = 0.174$), and Action Research Productivity ($\beta = 0.070$, $p = 0.154$) showed no significant direct effects on their targeted outcomes.

Table 7. Results of hypothesis testing.

Hypothesis	Path	β	p -value	f^2	Decision
H1	TTP $\rightarrow$ ARP	-0.085	0.106	0.044	Not supported
H2	EUP $\rightarrow$ ARP	0.342	<0.001	0.202	Supported
H3	TSA $\rightarrow$ ARP	0.384	<0.001	0.229	Supported
H4	DRU $\rightarrow$ TBCI	-0.064	0.174	0.013	Not supported
H5	TEC $\rightarrow$ DRU	0.725	<0.001	0.525	Supported
H6	DA $\rightarrow$ TBCI	0.735	<0.001	0.549	Supported
H7	ARP $\rightarrow$ TBCI	0.070	0.154	0.009	Not supported

5. Discussion

The pattern of results identifies usability, institutional support, collaboration, and data accessibility, rather than raw technical proficiency, as the working enablers of technology-supported action research. Teachers produce more and better research when digital systems are intuitive and when schools provide reliable assistance, guidance, and training, consistent with technology-integration research emphasizing the conditioning role of support environments (Peng et al., 2023; Cheng & Parker, 2023). The large effect of Technology-Enhanced Collaboration on Digital Resource Utilization indicates that shared platforms and professional learning communities drive teachers' productive use of digital resources (Martinović & Milner-Bolotin, 2024), while the dominant effect of Data Accessibility on Technology-Based Classroom Innovation shows that innovation follows when teachers can actually reach research and instructional data.

The unsupported paths are equally consequential. Technology Tools Proficiency, despite obtaining the highest descriptive mean (4.84), did not significantly predict Action Research Productivity, indicating that skills saturate quickly and that productivity gains depend on the surrounding system rather than on additional competence alone. Similarly, neither Digital Resource Utilization nor Action Research Productivity directly produced classroom innovation, suggesting that completed research and resource use do not automatically translate into instructional change without accessible data infrastructures and deliberate translation mechanisms (Adipat et al., 2023; Selialia & Kurata, 2023). For DepEd admin-

istrators, the practical sequence is clear: invest in user-friendly systems and responsive institutional support to raise research productivity, cultivate collaborative digital environments to mobilize resources, and prioritize data access, especially in the rural schools that comprised 88% of this sample and where a third of teachers reported rarely accessible technology.

6. Conclusions and Recommendations

Technology plays a critical and multifaceted role in supporting teachers' action research practices in DepEd Region VIII, but its benefits are realized through enabling conditions rather than proficiency alone. The unified TICT-ARDIT framework was empirically validated with strong measurement properties and large overall model quality, and the supported pathways establish that ease of use and technological support drive research productivity, collaboration drives digital resource utilization, and data accessibility drives classroom innovation. Evidence-based instructional improvement is therefore most effectively achieved when systemic, infrastructural, and collaborative supports are in place.

Based on the findings, the Evidence-Driven Digital Innovation Action Cycle (EDDAC) Framework is proposed, structuring repeated action research loops of data collection, evaluation, and refinement of technology-enabled interventions. It is recommended that DepEd Region VIII strengthen technological support infrastructure, particularly reliable ICT resources and connectivity in rural schools with consistent support from IT personnel; provide targeted capacity-building focused on the practical application of digital tools for research rather than generic skills training; institutionalize technology-enhanced collaboration through shared platforms and professional learning communities; and invest in accessible research data systems that allow teachers to translate findings into classroom innovation. The framework should be validated by experts, pilot-tested across urban and rural divisions, and refined through implementation evidence.

The findings should be interpreted in light of the study's exploratory, cross-sectional, self-report design, the purposive sample drawn from a single Philippine region with a predominantly rural composition, and the absence of objective productivity or innovation measures. Future research should replicate the model with probability samples across regions, incorporate longitudinal and objective indicators, and examine mediating mechanisms, such as institutional culture and workload, that may explain why proficiency and productivity did not directly yield innovation.

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Author Contributions

Conceptualization, J.S. and J.M.O.; methodology, J.S.; software, J.S. and R.S.B.T.;

validation, Re.R., Ro.R., and R.G.A.; formal analysis, J.S. and Re.R.; investigation, J.S.; resources, Ro.R. and R.G.A.; data curation, J.S. and R.S.B.T.; writing—original draft preparation, J.S.; writing—review and editing, Re.R., Ro.R., R.G.A., R.S.B.T., and J.M.O.; visualization, R.S.B.T.; supervision, J.M.O.; project administration, J.M.O. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request; the data are not publicly available because they contain information that could compromise the privacy of the participating teachers and schools.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix A. Survey Instrument

The complete 40-item questionnaire administered to respondents is reproduced below, organized by construct. All items were rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Items are researcher-developed, grounded in the Technology Acceptance Model (Davis, 1989), the TPACK framework (Mishra & Koehler, 2006), and the technology-integration literature, and contextualized to Philippine Department of Education platforms and workflows; content validity was established through expert-panel review as described in Section 3.3.

Technology Tools Proficiency (TTP)

TTP1. I am confident in using technology tools such as Google Forms, Excel, or DepEd's Learning Resource portal to collect research data during school-based action research.

TTP2. I can use software like Google Sheets or statistical tools to organize, analyze, and interpret data for action research tasks with ease.

TTP3. I find visual tools like charts, graphs, or DepEd template forms useful for presenting my research findings effectively during school meetings.

TTP4. I can troubleshoot common technical issues such as connectivity problems, software glitches, or formatting errors while conducting action research tasks.

TTP5. I use technology tools like PowerPoint, Canva, or cloud sharing platforms to document my findings and present them to school heads and stakeholders.

Ease of Use Perception (EUP)

EUP1. I find it easy to integrate technology (e.g., DepEd LMS or ICT tools) during my action research activities, especially during data collection and analysis.

EUP2. The digital tools I use, such as DepEd Commons and online survey software, are user-friendly and intuitive, making my research process smoother.

EUP3. Navigating technology platforms like Google Workspace or DepEd Learning Portals feels comfortable when conducting research and synthesizing findings.

EUP4. I find that the technology tools I use, such as e-classrooms and automated survey tools, reduce the effort required to implement effective research.

EUP5. Easy access to digital resources provided by DepEd, such as e-libraries or webinars, significantly improves my productivity during research tasks.

Technological Support Availability (TSA)

TSA1. My school provides sufficient technical support, such as access to laptops or projectors, for using technology in action research activities.

TSA2. I can seek assistance from IT personnel or ICT coordinators for troubleshooting technology issues during data collection or report generation.

TSA3. Administrative support, such as guidance from subject coordinators, is available for integrating appropriate technology tools into action research processes.

TSA4. The ICT tools I need, such as computer labs or teaching aids provided by the school, are always accessible to help me complete my research.

TSA5. My school organizes training sessions on using technology tools like Google Workspace or DepEd Portals, which improve my proficiency in conducting action research.

Action Research Productivity (ARP)

ARP1. Technology tools such as Excel or automated reporting software help me complete action research tasks more efficiently and save time.

ARP2. Using digital tools like Canva, LMS dashboards, or digital trackers enhances the quality of my research findings and outputs.

ARP3. Platforms such as Google Forms or DepEd LR portals allow me to complete steps in my action research process in a timely and organized manner.

ARP4. Technology reduces errors in my research processes, such as calculation errors or data mismanagement, ensuring accurate and reliable findings.

ARP5. I use technology tools like online templates or visual design software to create impactful and well-presented research reports that resonate with stakeholders like supervisors or school heads.

Digital Resource Utilization (DRU)

DRU1. I effectively use online resources such as DepEd Commons or free e-libraries to find relevant materials for my research, helping me better understand the topics I explore.

DRU2. I rely on free e-journals, YouTube tutorials, or DepEd-developed online modules to guide my action research and inform my teaching strategies.

DRU3. I consult educational websites such as the DepEd LR Portal, online learning hubs, or webinars to enhance my research methods and practices.

DRU4. I use downloadable learning materials (such as those provided by DepEd or other trusted sources) to improve the quality and relevance of my research outcomes.

DRU5. I access online databases or archives like Google Scholar to collect evidence or references that support the findings of my research.

Technology-Enhanced Collaboration (TEC)

TEC1. I utilize Microsoft Teams, Google Meet, or Facebook groups to collaborate with colleagues when developing action research projects.

TEC2. I use platforms like DepEd email or group chats to share my research findings with fellow teachers and administrators for their feedback and recommendations.

TEC3. I use Google Forms, collaborative Google Docs, or Excel files to gather data and analyze responses for my research projects, allowing other teachers to contribute their ideas.

TEC4. I participate in educator webinars or online communities to discuss and improve my action research proposals or results.

TEC5. Virtual platforms like DepEd-supported learning management systems (e.g., LMS) enhance the collaborations I have with colleagues when designing or

implementing research projects.

Data Accessibility (DA)

DA1. I use cloud storage tools like Google Drive or sharing platforms like DepEd ICT repositories so I can access my research data anytime, even outside of school hours.

DA2. I organize my action research data using accessible technologies such as Excel sheets, Google Sheets, or other DepEd-supported digital systems to keep my files structured and ready for use.

DA3. Technology tools like LMS databases facilitate the retrieval of my research data whenever I need it for reporting or evaluation purposes.

DA4. Cloud-based solutions like Google Workspace or other secure online storage tools help me safeguard sensitive data while remaining accessible for my action research needs.

DA5. Quick access to digitally archived observations and records empowers me to make prompt and accurate decisions that inform my teaching strategies.

Technology-Based Classroom Innovation (TBCI)

TBCI1. I use insights from my action research involving technology tools, such as educational games or simulations, to improve students' academic performance and engagement.

TBCI2. I integrate tools like Kahoot! Google Classroom, or Microsoft PowerPoint into my lessons based on findings from my action research, making my teaching strategies more aligned with students' needs.

TBCI3. I experiment in my teaching with new technologies, such as interactive whiteboards or videos, that reflect positive results from my action research studies conducted in alignment with DepEd frameworks.

TBCI4. Using results from my action research projects with digital tools, I design improved lesson activities that promote active student participation in class.

TBCI5. I develop differentiated learning strategies for students, such as assigning technology-enhanced tasks (videos, apps, or online modules) tailored to their skill levels, based on findings from my action research.