Journal of Educational Technology and Learning Creativity
Vol. 3, No. 2, December 2025, pp. 269~281
ISSN: 3021-7865, DOI: 10.37251/jetlc.v3i2.2301

Technology-Enhanced Action Research Training for Science Teachers: An Explanatory Sequential Mixed-Methods Needs Assessment

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Article Info

Article history:

Received Oct 3, 2025
Revised Nov 7, 2025
Accepted Dec 10, 2025
Online First Dec 27, 2025

Keywords:

Action Research
Mixed Methods
Professional Development
Science Education
Training Needs Analysis

ABSTRACT

Purpose of the study: This study aimed to determine the training needs of science teachers in conducting action research and to examine the relationship between their prior research experience and confidence in performing research-related tasks.

Methodology: An explanatory sequential mixed-methods design was used. Data were collected through a validated online survey of 24 science teachers in Cagayan de Oro City, Philippines, followed by semi-structured interviews with eight participants. Data were analyzed using descriptive statistics, Spearman's rho correlation, and thematic analysis to examine teachers' perceptions of digital tools and technology-enabled support in enhancing action research competence.

Main Findings: Teachers showed high confidence in identifying research problems but low confidence in technical areas such as data analysis and research writing stages where digital tools could offer substantial support. Prior research experience significantly correlated with confidence in data analysis ($\rho = 0.439$, $p < 0.05$). Qualitative findings highlighted barriers such as limited mentoring, time constraints, and lack of institutional structures to support technology based research training. Teachers expressed strong interest in technology enhanced mentoring, online analytics workshops, and digital writing support tools.

Novelty/Originality of this study: This study contributes a novel sequential explanatory framework for diagnosing science teachers' research competencies while integrating technological considerations into professional development design. Unlike prior assessments relying solely on traditional surveys, this study foregrounds how digital platforms, online mentoring, and technology enhanced training models can address persistent skill gaps. The findings offer actionable insights for designing innovative, technology supported research capacity-building programs for science teachers.

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1. INTRODUCTION

Action research is increasingly recognized as a meaningful pathway for teacher professional learning, as it situates inquiry within classroom realities and positions teachers as knowledge producers rather than mere implementers of prescribed reforms [1], [2]. In science education, where experimentation and evidence-based

reasoning underpin both curriculum and pedagogy, action research allows teachers to test instructional innovations, document student learning, and refine practice through iterative cycles of planning, action, observation, and reflection. This practice-based inquiry orientation aligns with global trends emphasizing teacher agency and reflective professionalism.

Despite its promise, consistent challenges limit teachers' full engagement in action research. Studies from Europe, Australia, and Southeast Asia show that teachers are typically confident in conceptual tasks such as identifying classroom problems or drafting initial proposals but experience low confidence in methodological tasks, including research design, data analysis, and scholarly writing. These technical barriers are compounded by structural constraints such as limited mentoring, inadequate time, and competing administrative workloads [5], [6]. International reviews highlight that, even in systems where action research is institutionalized, only a small subset of teachers complete rigorous research cycles.

In the Philippines, action research has become a formal requirement through the Department of Education's (DepEd) Research Management Guidelines and promotion policies. However, national data show a wide gap between eligibility and participation: although more than 900,000 basic education teachers are qualified to conduct research, fewer than 2% submit proposals yearly under the Basic Education Research Fund (BERF), and only 0.3% receive grants [7]. Recent studies attribute this low uptake to insufficient methodological preparation, statistics anxiety, and the absence of sustained mentoring structures [8], [9]. For science teachers—whose disciplinary practices demand rigorous inquiry these gaps may be more pronounced, yet empirical studies focusing specifically on their research competence remain limited.

While these methodological and structural challenges persist, a critical yet underexamined dimension is the limited use of technology-enhanced professional development to support teacher research. Across educational systems, digital tools such as online learning management systems, virtual mentoring platforms, data visualization software, and cloud-based collaborative workspaces have become essential components of teacher professional learning, especially when research tasks require iterative feedback, guided practice, and continuous support. In the context of action research, these technologies can streamline literature searching, simplify data organization and analysis, and facilitate remote collaboration with mentors or research teams. However, despite their potential, most science teachers in the Philippines have minimal exposure to technology-supported research training, resulting in underutilization of digital tools that could reduce cognitive load, improve analytic accuracy, and enhance research self-efficacy. This gap underscores the need to examine not only teachers' methodological competencies but also their readiness for and access to technology-enabled research capacity-building—an aspect that remains largely absent from existing local studies.

Existing Philippine research provides important insights but is mainly quantitative, focusing on teachers' self-reported skills, attitudes, or challenges (e.g., Morales et al., 2016; Tan-Cortes, 2019). While these studies reveal general patterns of low methodological confidence, they rarely probe why these gaps persist or how teachers' experiences explain quantitative trends. International scholarship similarly calls for mixed-methods approaches that connect competence assessments with lived experiences to better understand how self-efficacy, experiential learning, and institutional culture shape teacher research engagement [6], [10].

Several intersecting factors help explain why teachers struggle to move from conceptual understanding to methodological execution. First, pre-service and in-service programs often emphasize declarative knowledge (e.g., research terminology, report structure) without providing extended, mentored opportunities to practice the full research cycle [11]. Second, institutional constraints heavy teaching loads, limited access to mentors, and weak incentives for dissemination reduce teachers' capacity to plan, implement, and complete research projects [5]. Third, affective barriers such as anxiety about statistical methods and fear of critique can discourage teachers from attempting technical tasks without supportive scaffolding [3]. Together, these factors produce a situation in which motivated teachers may start research projects but stall at stages that require technical or analytic expertise.

These gaps are particularly salient in the context of Cagayan de Oro City, Philippines, where secondary science teachers are subject to national and divisional professional requirements that increasingly foreground teacher inquiry. Yet local evidence suggests that many science teachers lack the methodological confidence and institutional supports necessary to undertake action research as an authentic form of professional learning rather than a bureaucratic obligation [4], [5], [12]. Understanding both the distribution of training needs and the mechanisms that produce those needs is essential for designing capacity-building initiatives that are practicable, sustained, and contextually appropriate.

Accordingly, this study employs an explanatory sequential mixed-methods design to (a) map science teachers' confidence across key stages of action research, (b) examine the relationship between prior research experience and competence, and (c) explain these quantitative patterns through qualitative accounts of teachers' challenges and contextual realities. By integrating reflective, experiential, and sociocultural dimensions, the study aims to generate nuanced, evidence-informed insights for designing effective, context-responsive research capacity-building programs for science teachers.

2. THE COMPREHENSIVE THEORETICAL BASIS

2.1 Teacher Action Research

Teacher action research has transitioned from a grassroots movement to an institutionalized form of practitioner inquiry that systematically connects classroom practice with evidence-informed decision-making [5]. In science education, it operates both as a structured improvement process and as a reflective lens through which teachers interrogate and refine their instructional approaches [12]. International studies have shown that teachers who engage in action research demonstrate stronger reflective judgment, increased confidence, and a deeper understanding of scientific inquiry as it applies to pedagogy [6], [13]. These benefits are consistent across diverse educational systems such as in Australia, Canada, and the United Kingdom where practitioner inquiry is now integrated into professional standards and teacher appraisal frameworks.

Global research also identifies persistent barriers to teacher research engagement. Laudonia et al. [1] and Oancea et al. [6] found that while teachers in developed countries express enthusiasm for inquiry, only a small subset successfully complete research cycles, often citing technical and methodological challenges. Recent studies in East and Southeast Asia show similar patterns: teachers frequently identify classroom problems but struggle with research design, quantitative analysis, and scholarly writing [10], [14], [15].

Despite these advantages, a persistent research competence gap remains. Morales et al. [8] reported that while Filipino science teachers express high motivation to conduct research, they lack methodological competence in instrument development, data analysis, and reporting. Similar trends were observed in Europe and Southeast Asia, where teachers could identify authentic problems of practice but struggled with the analytic demands of research design and interpretation [6], [9]. This convergence of findings underscores a global challenge: teachers are expected to conduct research, yet many have not been adequately prepared to do so.

In the Philippines, the Department of Education's emphasis on action research as a requirement for promotion further amplified these gaps. While the policy succeeded in democratizing research participation, it also revealed systemic constraints. Tan-Cortes [16] and Nicolas et al. [9] noted that teachers often perceive research as an administrative burden arising from a lack of mentoring, heavy workloads, and limited institutional resources. International research corroborates this: Oancea et al. [6] found that sustainable research engagement requires a culture that values practitioner-generated evidence and provides embedded support mechanisms.

Existing professional development (PD) programs remain heavily workshop-oriented [17], [18]. Evidence demonstrates that short, compliance-oriented research seminars generate superficial knowledge that quickly fades after training [3], [16], [19]. Conversely, experiential, mentored PD programs where teachers learn by conducting real research result in deeper competence gains and durable changes in practice [20]. These models emphasize authentic inquiry cycles, immediate feedback, and situated coaching, suggesting that teacher research competence develops most fully through scaffolded, practice-based experiences rather than one-off lectures.

Although local and international studies have examined teacher readiness for action research, few have focused specifically on *science teachers*, whose research needs are shaped by the epistemologies of scientific inquiry. There is also little empirical evidence nationally or internationally on how quantitative assessments of teacher research competence can be *explained* through qualitative insights, especially within real contexts of policy pressure, workload, and resource constraints. This study addresses this gap using a sequential explanatory mixed-methods design, linking numerical trends with teacher narratives to provide a deeper understanding of training needs among science teachers in Cagayan de Oro.

2.2. Theoretical Lenses of the Study

This study is guided by three interrelated theoretical traditions: reflective practice, experiential learning and self-efficacy, and communities of practice. Schön's reflective practice theory positions teacher inquiry as a disciplined process of reflection-in-action and reflection-on-action [13]. In the context of action research, teachers identify classroom problems, implement interventions, and evaluate outcomes using systematic reflection. This theoretical lens directly informs survey items on problem identification, research planning, and reflective refinement of practice.

Kolb's experiential learning cycle emphasizes learning through doing concrete experience, reflective observation, abstract conceptualization, and active experimentation [21]-[23]. As teachers conduct authentic research activities (e.g., data collection, analysis, intervention refinement), they move through this experiential cycle, building not just procedural knowledge but adaptive expertise. Bandura's self-efficacy theory complements this by explaining how successful research experiences especially mentored ones strengthen teachers' confidence to perform research tasks [24], [25]. Survey items on perceived competence, confidence in data analysis, and confidence in writing research reports are grounded in this theoretical perspective. Mastery experience, the strongest source of efficacy, is particularly relevant for teachers who have never completed a research project independently.

Wenger's communities of practice framework conceptualizes teacher research as a socially mediated process shaped by shared norms, modeling, and participation within a professional community [12]. Research

engagement is sustained through collaborative inquiry, peer feedback, and mentoring structures elements reflected in survey items related to collaboration, mentorship, and institutional support for research. This lens also guided the design of the qualitative interviews, which probed how social and institutional factors influenced teachers' research experiences.

Recent developments in teacher education highlight the increasing role of technology-supported professional development (TPD) in shaping how teachers acquire, practice, and sustain research competencies. Digital tools such as online learning management systems, virtual mentoring platforms, collaborative cloud workspaces, and user-friendly data analysis applications have reconfigured the ways teachers participate in inquiry-oriented learning. TPD models emphasize sustained, flexible, and just-in-time learning opportunities, enabling teachers to revisit training materials, receive asynchronous feedback, and engage in collaborative problem-solving beyond traditional face-to-face sessions. In the context of action research, technology affords teachers the ability to streamline data collection, organize qualitative and quantitative information efficiently, and engage with research coaches or communities of practice regardless of geographical or scheduling constraints. This lens complements experiential learning and self-efficacy theories by recognizing that digital scaffolds can reduce cognitive load, enhance access to expertise, and create ongoing cycles of feedback conditions necessary for building confidence in complex research tasks such as analysis and writing. Incorporating a technology-enhanced PD perspective therefore helps explain how digital tools can mediate teachers' research engagement, shape their perceived competence, and support the sustainability of research practices.

2.3. Theoretical Framework of the Study

Drawing from these theories, the study advances a Situated and Scaffolded Teacher Research Competence Framework, integrating reflective practice, experiential learning, self-efficacy mechanisms, and socially mediated learning. The framework rests on four propositions:

1. Iterative Practice: Research competence develops through locally situated cycles of inquiry classroom action, observation, reflection, and revision not through isolated training workshops [13], [21].
2. Experiential Mastery: Mentored engagement in authentic micro-research projects creates mastery experiences that strengthen methodological confidence and readiness for more complex research tasks [21], [24].
3. Social Mediation: Communities of practice support teachers through modeling, collective problem-solving, and shared accountability, increasing persistence and research completion rates [26].
4. Institutional Alignment: Research mandates must co-exist with structures that provide time, resources, and mentoring; otherwise, action research becomes compliance-driven and unsustainable [6], [16].

To reflect the growing role of digital environments in teacher learning, the framework also incorporates principles of technology-enhanced professional development. Digital tools and online platforms can provide flexible avenues for mentoring, feedback, and analytic guidance supports that are often limited in traditional PD formats. By embedding technology-enabled scaffolds within inquiry cycles, teachers can engage more frequently and more confidently in the procedural aspects of action research. This addition strengthens the framework's explanatory power by acknowledging that research competence develops not only through reflective, experiential, and social processes but also through technology-mediated learning that extends access to expertise, resources, and collaborative spaces. This framework guided both the construction of the quantitative instrument and the analytic approach in the qualitative phase. By integrating reflective, experiential, and sociocultural dimensions, the model provides a comprehensive lens for identifying and explaining the research training needs of science teachers.

3. RESEARCH METHOD

3.1 Research Design

This study utilized an explanatory sequential mixed-methods design, consisting of two interconnected phases: a quantitative survey followed by qualitative semi-structured interviews [27]. The quantitative phase was designed to identify trends in science teachers' confidence, perceived training needs, and research engagement. The qualitative phase subsequently explored the underlying factors that could explain those trends in greater depth.

This sequential design allows quantitative data to establish a broad understanding of patterns, while qualitative data provide contextual explanations of the "why" behind those patterns [28]. The mixed-methods approach was selected to address the complex, multidimensional nature of teacher competence in research a domain influenced by cognitive, affective, institutional, and social variables [22]. Integration of both strands occurred in two stages: during the design of the qualitative interview protocol [29] (which was informed by the survey findings) and during interpretation, where themes were used to elaborate the quantitative results.

3.2 Research Contexts and Participants

The research was conducted in Cagayan de Oro City, Philippines, an urban education division recognized for its active implementation of the Department of Education's teacher research programs. The division includes a mix of junior and senior high schools that vary in size, resources, and access to professional development. A total of 24 science teachers participated in the quantitative phase. Although the sample size of 24 teachers appears modest, it is adequate for an exploratory mixed-methods design because the participants represent the full set of science teachers engaged in the division's action research initiative for that school year. This provides a census-like snapshot of the group under study. Moreover, similar TNA and self-efficacy studies in the literature have used comparable sample sizes for exploratory aims [30].

Although the sample consisted of 24 science teachers, this size is acceptable for exploratory mixed-methods studies where the intent is to identify emerging competence patterns rather than to estimate population parameters. Mixed-methods literature recognizes that small, purposeful samples are appropriate when complemented by qualitative follow-up inquiry [20]. For correlation analyses, small samples ($n < 30$) can lead to unstable estimates; hence Spearman's rho was used because it is robust to non-normal data, ordinal scales, and small sample sizes. Simulation studies demonstrate that Spearman's rho maintains acceptable bias and precision even with samples between 15 and 30, especially when correlations are moderate to high [31]. Additionally, Spearman's correlation is preferable when assumptions of normality and linearity are not met [32]. Effect sizes were interpreted with caution following Cohen's benchmarks for correlation magnitude [30]. The sample represents more than one-third of the science teacher population in the division, making the dataset locally meaningful for a training needs analysis.

Most participants (70.8%) had no prior experience conducting action research, and nearly half (45.8%) had between one and five years of teaching experience. This distribution captures the demographics typical of science teachers in mid-sized Philippine divisions relatively young and motivated educators navigating the expectations of new professional standards [16], [33]. For the qualitative phase, eight teachers were purposively selected from the quantitative cohort using maximum variation sampling [34]. Selection criteria included variation in confidence scores, teaching experience, and prior research exposure. This ensured the inclusion of participants with different levels of competence and experience, providing a range of perspectives on the challenges and enablers of action research. Among the interviewees, five teachers had not previously completed an action research project, while three had finished at least one. This composition allowed the analysis to contrast perspectives between novice and more experienced teacher-researchers.

3.3. Data collection

The survey instrument was developed using a theory-driven process. Initial constructs were derived from three theoretical strands: reflective practice theory, experiential learning/self-efficacy, and communities of practice. Item generation followed a deductive approach, drawing on existing validated frameworks of teacher research competence from prior studies. Specifically, Morales et al. [8] informed the domains of problem identification and reflective planning; Tan-Cortes [4] provided guidance on research design and data handling items; and Wenger's [12] community-based learning theory shaped items related to collaboration and mentoring. Items were aligned with competencies identified in DepEd's Research Management Guidelines. The resulting 25-item scale used a 5-point competence self-rating. Content validity was established through expert review by two science education specialists and one research methods expert.

The quantitative phase employed a researcher-developed and validated survey instrument composed of three sections:

1. Confidence in performing research tasks,
2. Perceived training needs, and
3. Interest in training participation.

Confidence and interest items were rated on a five-point Likert scale (1 = Very Low to 5 = Very High), while training needs were measured using binary responses ("Yes/No"). The instrument was reviewed by three experts in science education and research methodology for content validity, and a pilot test with 10 teachers outside the final sample yielded a Cronbach's alpha of 0.89, indicating strong internal consistency [35].

Sample items include "*I can formulate a clear, researchable classroom problem", "I can select appropriate data collection methods for action research", "I can compute basic descriptive statistics (e.g., mean, frequency)", "I can interpret qualitative responses from students or colleagues","I can write a complete action research report aligned with DepEd guidelines*."

The survey was administered online via Google Forms, with distribution facilitated by the participating schools' science department heads. Participation was voluntary and anonymous. The qualitative phase followed the analysis of survey results and sought to clarify the reasons behind observed quantitative trends. A semi-structured interview guide was designed to explore key issues emerging from the quantitative data such as low confidence in data analysis and writing, or uncertainty about methodological steps.

Each interview lasted approximately 45–60 minutes and was conducted either face-to-face or via Zoom, depending on participants' preference. All interviews were audio-recorded with consent and transcribed verbatim. Field notes were taken to record non-verbal cues and contextual details.

Sample guiding questions included:

- "What challenges do you face when conducting action research?"
- "Which parts of the research process do you feel least confident about?"
- "What kind of support or training would help you conduct research more effectively?"
- "How does your school or supervisor support your engagement in research?"

These open-ended prompts encouraged participants to share personal experiences and perceptions that helped interpret and explain the quantitative findings.

To strengthen validity, member checking was conducted by returning the coded themes to all interview participants for verification. Minor clarifications were incorporated. Additionally, two independent coders reviewed the qualitative dataset, and inter-coder agreement reached 87%, indicating substantial reliability.

Technology played a central role in both phases of the data collection process. The quantitative survey was administered using Google Forms, which allowed teachers to access the instrument through their mobile phones, laptops, or school-issued devices. The digital format supported automated timestamping, error-checking for missing responses, and secure cloud-based storage of participant inputs. For the qualitative phase, interviews were conducted either via Zoom or face-to-face depending on participants' availability, with Zoom's built-in recording function used (with consent) to ensure accurate capture of responses. Digital transcription tools were used for initial text generation before manual verification by the researchers. These technology-supported procedures improved efficiency, minimized logistical barriers for teachers with heavy workloads, and enabled flexible scheduling across multiple schools. The integration of accessible digital tools reflects current trends in technology-enhanced research practices and supports the journal's focus on technology-enabled learning environments.

3.4. Data analysis

Descriptive statistics (mean, frequency, and percentage) were computed to summarize levels of confidence, training needs, and interest. Relationships between prior research experience and confidence scores were analyzed using Spearman's rho correlation, an appropriate non-parametric measure for ordinal data and small samples [36]. Qualitative data were analyzed through reflexive thematic analysis, following Braun and Clarke's [37] six-phase approach: (1) familiarization, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) writing up. Coding was conducted inductively by two researchers, who subsequently discussed and refined the themes to ensure interpretive coherence.

Integration occurred during interpretation quantitative patterns were explained using qualitative themes and verbatim statements from participants. For instance, low confidence in writing tasks (identified quantitatively) was illuminated by participants' comments about their uncertainty in academic writing conventions and lack of feedback opportunities. Given the small sample size and ordinal nature of the competence ratings, Spearman's rho was used to examine associations among variables. Spearman's correlation is recommended for $n < 30$ because it does not assume normal distribution and relies on rank-order consistency rather than raw values. Recent methodological reviews affirm that Spearman's rho yields stable and interpretable coefficients at small sample sizes, especially when supported by triangulation. Thus, quantitative correlations were integrated with qualitative interview findings to enhance interpretive rigor.

3.5. Ethical considerations

The study was conducted in compliance with ethical research principles and was approved by the University of Science and Technology of Southern Philippines – Research Ethics Review Committee (USTP-RERC). Participation was voluntary, and informed consent was obtained prior to both the survey and interviews. All data were anonymized, and participants were assured that their responses would remain confidential. Teachers could withdraw at any time without penalty. The study adhered to the principles of respect for persons, beneficence, and justice as articulated in the Philippine National Ethical Guidelines for Health and Social Science Research (2023).

4. RESULTS AND DISCUSSION

This section integrates quantitative and qualitative findings to explain science teachers' action research competencies through an explanatory sequential design. The results consistently reveal three interacting mechanisms shaping teachers' research competence: (1) strong conceptual confidence grounded in reflective practice, (2) persistent technical challenges linked to limited experiential learning and research self-efficacy, and (3) institutional constraints such as workload and limited mentoring opportunities. These mechanisms help account for the relationships observed in the quantitative phase and the explanations provided in the qualitative phase.

4.1. Overall Levels of Action Research Competence

To establish a baseline understanding of teachers' research capacities, Table 1 presents the degree of confidence across eight action research competencies. Quantitative findings show that confidence is highest in identifying research parts (M = 4.17) and identifying research problems (M = 4.13), while competence is lowest in data analysis (M = 3.92) and research writing (M = 3.88). This mirrors the patterns reported in previous Philippine studies, where teachers are most comfortable in conceptual tasks but struggle with technical processes such as statistics, methodology alignment, and academic writing [8], [16], [33].

Table 1. Teacher's Confidence in different research-related tasks

Research-related tasks	Mean	Standard Deviation	Interpretation
Identifying parts of a research	4.17	0.82	High
Identifying research problems	4.13	0.80	Moderate
Conducting Literature Review	4.04	0.69	Moderate
Designing research methodologies	4.00	0.83	Moderate
Analyzing Data	3.92	0.83	Low
Writing Research Reports	3.88	0.80	Low
Managing Research Projects	4.00	0.72	Moderate
Presenting Research Reports	4.13	0.74	Moderate

Interview responses offered deeper insight. Teachers expressed that early-stage tasks are "natural" extensions of reflective teaching. One teacher explained, *"We see the problems every day, so identifying them is the easiest part."* Another stated, *"I can propose a project, but when it comes to actual analysis, I hesitate."* These accounts support Bautista's finding that reflective competence emerges organically from professional practice, whereas methodological competence requires explicit training and guided practice [9].

The pattern of high confidence in conceptual tasks but lower confidence in technical competencies is consistent with longstanding findings in the Philippine action research literature. Morales et al. [8] similarly reported that teachers readily identify classroom problems because these are part of their daily reflective practice, but they often lack the methodological grounding needed to translate problems into systematic investigations. This suggests that teachers' "confidence in problem identification" is often grounded in experiential familiarity rather than in formal research planning skills. This aligns with Schön's reflective practice theory [13], which explains why teachers naturally excel in articulating classroom issues but struggle in transforming these reflections into empirically testable research designs.

Moreover, the relatively lower confidence in data analysis and research writing echoes Tan-Cortes' (2019) findings [4] that teachers frequently stall during these stages due to limited exposure to authentic, hands-on research tasks. In the present study, interview statements describing analysis as "overwhelming" or "intimidating" mirror the statistics anxiety that has been documented among Filipino teachers [16], revealing that emotional responses also influence competence perceptions. Teachers' narratives highlight that the initial phases of research feel manageable because they resemble professional tasks they already perform—lesson planning, diagnosing student needs, or reflecting on practice. In contrast, analysis and writing require specialized knowledge they have not had sufficient time or mentoring to master. This reinforces the arguments of Laudonia et al. [38] and Shaik-Abdullah et al. [10] that technical stages are often the bottleneck that prevents teachers from completing action research cycles across diverse educational systems.

4.2. Perceived Training Needs Across the Research Process

Teachers' perceived training needs across the research process are summarized in Table 2. Data analysis and interpretation (91.7%) was the highest-ranked need, followed by research writing (83.3%) and research design (75%). These results triangulate strongly with the competence ratings from Table 1 and with earlier Philippine findings that analytics and writing are persistent bottlenecks in action research [8], [16].

Table 2. Perceived Training Needs in Conducting Action Research

Research Stage	% of Teachers Needing Training	Rank
Data analysis and interpretation	91.7%	1
Research writing and publication	83.3%	2
Research design and methods	75.0%	3
Literature review	62.5%	4
Research ethics	54.2%	5
Dissemination and presentation	50.0%	6
Identifying researchable problems	33.3%	7

Interviews supported these findings. Teachers expressed uncertainty about selecting appropriate designs and tools, explaining: *"I don't know which method fits my problem."* The same uncertainty appears in international literature. Teachers across methodological confidence due to minimal exposure to research design principles [39], [40].

The high demand for training in analysis, writing, and methodology confirms that teachers are aware of the areas in which their competence is weakest an important indicator of readiness for professional learning. As adult learning theory suggests [40], teachers are most motivated to engage in training when they clearly perceive the gap between their current skills and the expectations of their role. This readiness is evident in the overwhelming percentage of teachers seeking support in data analysis (91.7%) and research writing (83.3%). These findings mirror earlier studies in the Philippines. For instance, Morales et al. [8] found that methodological and analytic skills consistently ranked as the teachers' strongest need, while Tan-Cortes and Reyes [16] documented that difficulties in data handling and interpreting results were among the most commonly cited barriers to completing research.

International evidence extends this pattern. Shaik-Abdullah et al. [10] noted that Southeast Asian teachers often identify researchable problems but lack confidence in choosing appropriate research designs. Similarly, studies in Europe and Australia confirm that teachers need extended mentoring to master analysis and interpretation [6], reinforcing the universality of the analytic challenge. The alignment of these patterns across contexts underscores that the challenge is systemic rather than individual. Teachers' heavy workloads, limited access to methodological experts, and minimal protected research time make it difficult for them to engage deeply with analytic tasks, resulting in persistent skill gaps despite strong motivation to learn.

4.3. Teachers' Interest in Research Capacity-Building Programs

Table 3 summarizes teachers' interest in specific research-related professional development topics. Interest levels were highest in mentoring (M = 4.67), data analysis workshops (M = 4.58), and research writing (M = 4.46). These findings support prior work arguing that effective research capacity-building must be experiential, mentored, and contextual [39], [40].

Table 3. Teachers' Interest in Research Training Areas

Training Topic	Mean Interest	SD	Interpretation
Research proposal writing	4.38	0.64	Very High
Data analysis workshop	4.58	0.52	Very High
Research writing and publication	4.46	0.59	Very High
Ethics in research	4.05	0.73	High
Research mentoring program	4.67	0.47	Very High

Teachers emphasized the importance of mentorship: "I can learn if someone guides me step-by-step." This aligns with the communities-of-practice model, which posits that competence emerges within supportive professional networks [41], [42]. Mentoring acts as both technical and emotional support, reducing research-related anxiety and promoting self-efficacy [39], [43]. These results call for programs that embed research mentoring into school structures rather than relying on isolated workshops.

The interviews affirm this interpretation: teachers expressed that they "learn best when guided step-by-step," which is consistent with findings from Flores [41] that mentoring enhances teachers' confidence by reducing the uncertainty associated with complex tasks. Patrick et al. [42] similarly argued that collegial learning enables teachers to negotiate challenges collectively, leading to more sustained engagement in professional activities. The strong interest in data analysis workshops and writing sessions also mirrors the results of Setiawan and Kuswandono [15], who reported that Southeast Asian teachers often prefer hands-on, context-driven PD that directly supports the tasks they struggle with most.

These findings collectively suggest that teachers are not resistant to research; rather, they are hindered by limited opportunities for scaffolded learning. The high interest in PD signals openness to participate in well-designed, mentored programs that meet their authentic professional needs.

4.4. Correlational Analysis: Linking Prior Research Experience and Competence

Spearman's rho correlation results (Table 4) revealed a significant positive association between prior research experience and confidence in data analysis ($\rho = 0.439$, $p < 0.05$). The correlation between research experience and confidence falls within the moderate range based on Cohen's classification, suggesting that teachers with greater prior exposure to research tend to report higher self-efficacy but the relationship is not strong enough to imply linear dependence. When converted to Cohen's d ($d \approx 0.98$), the effect size further suggests a large practical difference in analytic confidence between teachers with and without substantial research experience.

Table 4. Summary table of the correlation between experience in conducting action research and confidence in conducting research-related tasks

Research-related tasks	Correlation Value (ρ)	p-value
Identifying parts of a research	0.223	0.296
Identifying research problems	0.376	0.070
Conducting Literature Review	0.389	0.060
Designing research methodologies	0.347	0.096
Analyzing Data	0.439	0.031*
Writing Research Reports	0.208	0.329
Managing Research Projects	0.268	0.204
Presenting Research Reports	0.262	0.214

These results suggest that even limited exposure to authentic research processes has measurable effects on teachers' analytical competence. This aligns strongly with experiential learning theory, which asserts that mastery develops through iterative, authentic practice [22], [44].

Qualitative data reinforced this conclusion. Teachers with prior experience described research as "less overwhelming now," while inexperienced teachers often described themselves as "guessing." These experiential contrasts affirm that research competence is built slowly but decisively through real engagement rather than through theoretical seminars alone. Futher, teachers internalize research skills only through guided cycles of inquiry, where feedback and coaching are provided at each stage [41].

The moderate strength of the correlation also indicates that while experience matters, it is not the sole determinant of competence. Institutional supports, quality of mentoring, and school culture also play important roles. Oancea et al. [6] argued that teachers' research engagement is shaped by the broader research capacity of the institution access to mentors, cultural expectations, and opportunities for peer review. Thus, experience interacts with contextual factors, which helps explain why some teachers with experience still reported moderate confidence levels in tasks like writing or project management.

4.5. Institutional and Contextual Factors Shaping Research Competence

The institutional and contextual constraints identified in this study reflect not only individual teacher difficulties but deeper structural issues embedded in the broader educational system. Teachers' descriptions of research as "extra work" competing with administrative duties echo Tan-Cortes and Reyes [16], who found that biology teachers in Mindanao struggled to pursue action research because competing school responsibilities left little space for systematic inquiry. This finding is reinforced by local studies showing that research is frequently perceived as a compliance requirement rather than a meaningful professional learning activity [4], often due to limited time, absence of mentoring, and inconsistent administrative support. These structural pressures create what Oancea et al. [6] call "fragile research cultures," where teachers' willingness to engage in research is undermined by the very systems meant to promote it.

Interview results also reveal that the absence of supportive school structures such as protected research time, regular feedback mechanisms, and designated research mentors hinders teachers' ability to progress through analytic and writing stages. These barriers align with findings from Shaik-Abdullah et al. [10], who reported that Southeast Asian teachers' research engagement is shaped less by motivation and more by the degree to which schools institutionalize collaborative inquiry. The fact that teachers in this study frequently expressed uncertainty about whom to approach for guidance suggests that mentoring is sporadic rather than embedded, limiting opportunities for teachers to receive timely methodological support.

Furthermore, limited research culture manifests in teachers' concerns about the lack of recognition for research efforts and a perceived disconnect between administrative expectations and actual school-level resources. Nicolas et al. [9] similarly identified that when research outputs are neither acknowledged nor integrated into school improvement processes, teachers question the value of conducting research at all. This disconnect is compounded by heavy workloads, which have been consistently cited in Philippine and international literature as a primary deterrent to research engagement [4], [33]. Such workloads restrict teachers' capacity to engage in reflective planning an essential component of action research as described by Schön [13] and reduce opportunities for experiential learning cycles central to Kolb's model [21].

Collectively, these results demonstrate that teacher research competence is not solely a function of individual skill or motivation; rather, it is profoundly shaped by institutional environments. When teachers operate in contexts lacking mentoring, collaborative spaces, and structural incentives, they are less likely to sustain engagement with research, regardless of initial interest. Thus, addressing teachers' research training needs requires not only capacity-building interventions but also systemic reforms that cultivate stable, supportive, and inquiry-oriented school cultures.

These findings align with broader trends in the digitalization of education, wherein teachers are increasingly expected to engage in research and professional learning through technology-enabled platforms. The

observed gaps in data analysis, research writing, and methodological execution parallel global reports that many teachers lack the digital research skills needed to navigate contemporary tools for data processing, collaborative writing, or online literature sourcing. Teachers' expressed interest in mentoring, analytics workshops, and structured guidance suggests readiness to adopt digital tools such as cloud-based collaboration platforms, spreadsheet applications, or learning management systems to support these tasks. However, the qualitative accounts of limited mentoring and institutional support indicate that the digital shift in education has not yet translated into accessible technology-supported research ecosystems at the school level. This disconnect highlights that digitalization alone does not automatically empower teachers; rather, it must be paired with intentional capacity-building, structured digital scaffolds, and institutional cultures that support technology-enhanced inquiry. As schools increasingly integrate digital tools into teaching and professional development, the findings underscore the need to ensure that science teachers are equipped not only with methodological competencies but also with the digital literacy required to engage meaningfully in technology-supported action research.

The novelty of this study lies in integrating a mixed-methods approach with a technology-oriented perspective to examine science teachers' research competence. Unlike prior studies that primarily provide descriptive accounts, this research empirically reveals the relationship between teachers' prior research experience and their self-efficacy, while qualitatively explaining the underlying mechanisms. The findings indicate that teachers' primary challenges lie not in conceptual understanding but in technical competencies particularly data analysis and academic writing exacerbated by limited mentoring and underutilization of digital research tools. By positioning technology as a mediating factor in research capacity development, this study offers a refined conceptual understanding of how experiential learning, structured mentoring, and digital support can jointly strengthen science teachers' research competence in developing educational contexts.

The combined findings offer a cohesive theoretical explanation for teachers' action research competencies. As illustrated in Figure 1, the convergence of conceptual strengths, technical limitations, and institutional constraints produces a patterned landscape of research training needs. This thematic map situates science teachers' competencies at the intersection of reflective practice, experiential learning, self-efficacy, and communities-of-practice frameworks.

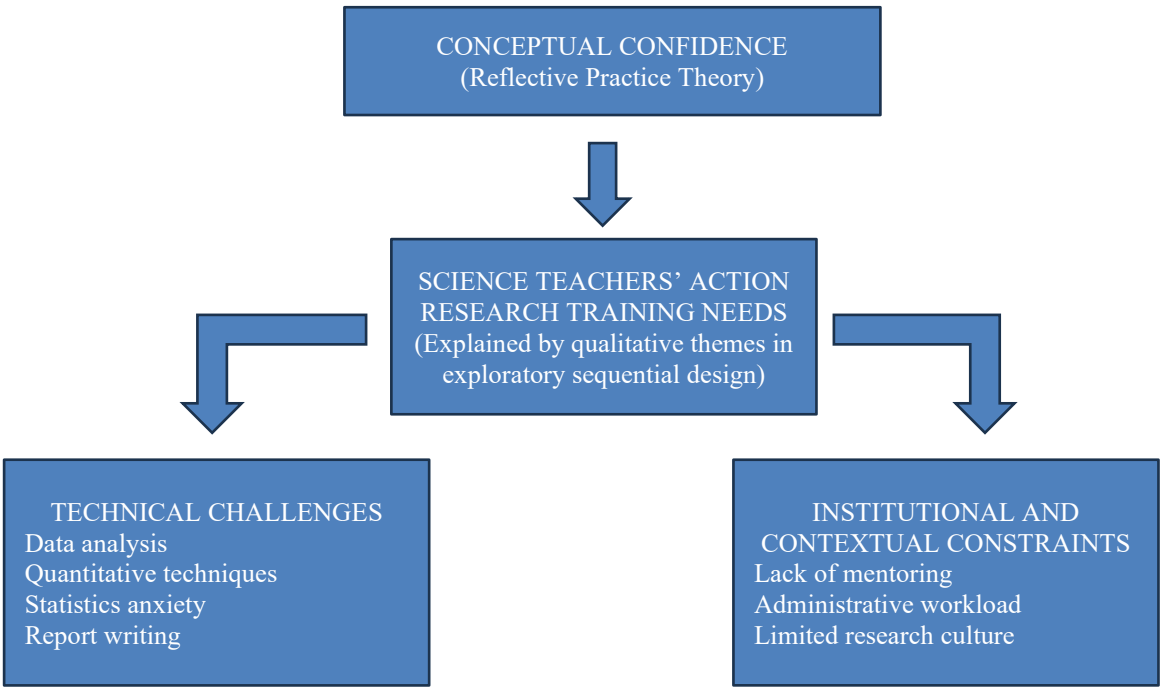

Figure 1. Thematic map showing the three major themes explaining science teachers' action research competencies. The map illustrates how conceptual confidence, technical challenges, and institutional constraints interact to shape teachers' research training needs

Teachers' high conceptual ratings are theoretically consistent with reflective practice, indicating that teachers can articulate and interrogate classroom issues but lack the procedural pathways to operationalize them. The technical challenges statistics anxiety, insufficient competence in quantitative analysis, and uncertainty in report writing are explained by experiential learning and self-efficacy theories, which emphasize that mastery develops through authentic, iterative experience rather than through passive or one-off workshops. Institutional barriers mentoring gaps, workload constraints, and limited research culture highlight that research engagement is a socially embedded process shaped by organizational norms and collaborative structures.\

These findings contribute theoretically by demonstrating that teacher research competence is not merely a linear skill but a multidimensional construct emerging from the interplay of reflection, experience, and social context. They refine existing theories by illustrating how reflective practice fosters conceptual readiness, experiential learning strengthens procedural mastery, self-efficacy mediates research-related anxiety, and communities of practice sustain long-term research engagement. This integrative perspective extends existing literature on teacher inquiry, particularly within developing educational systems.

Despite these contributions, several limitations should be acknowledged. This study was conducted with a relatively small, context-specific sample, which may limit the generalizability of the findings. The reliance on self-reported data also introduces potential perceptual bias, while the cross-sectional design constrains causal interpretation of how research competence develops over time. Future studies employing longitudinal and intervention-based designs are therefore needed to examine how technology-supported research capacity-building can sustainably enhance teachers' competencies.

Practically, the findings argue for a shift from compliance-oriented research training toward scaffolded, experiential, and mentored professional development. The data suggest several actionable directions: (1) implementing division-level mentoring programs with trained research coaches; (2) embedding protected research time within teachers' workloads; (3) establishing school-based communities of practice to support collaborative inquiry; (4) designing differentiated training modules targeting data analysis, academic writing, and research design; and (5) aligning DepEd research incentives with structures that sustain, rather than merely mandate, teacher research engagement. Together, these strategies reinforce that research competence is best developed through systems that intentionally integrate experience, reflection, collaboration, and technological support.

5. CONCLUSION

This study examined science teachers' action research competencies through an explanatory sequential mixed-methods design, revealing a consistent pattern across both data phases. Teachers demonstrated strong conceptual confidence particularly in identifying research problems and understanding research components yet faced persistent technical challenges in data analysis, interpretation, and research writing. These gaps were explained through reflective practice, experiential learning, self-efficacy, and communities-of-practice frameworks. However, the findings also highlight an important and emerging dimension: teachers' limited exposure to technology-supported research training. Although teachers expressed strong interest in mentoring, analytics workshops, and writing support, their qualitative accounts revealed that digital tools and online platforms now central to modern research practice are not yet fully integrated into their professional development experiences. This points to an unmet opportunity for schools and divisions to adopt technology-enhanced professional development models, such as virtual research mentoring, cloud-based collaboration, digital data analysis tools, and online communities of inquiry. Integrating these tools can reduce cognitive load in complex analytic tasks, expand access to methodological guidance, and create more sustainable cycles of reflective inquiry. Strengthening institutional structures such as protected research time, digitally supported mentoring, and school-based research networks can help counteract systemic workload barriers and foster a culture of inquiry that leverages both human and technological resources. Future research should examine how integrating digital tools into research capacity-building influences teachers' methodological confidence, the quality of their action research outputs, and long-term engagement with evidence-informed practice. As digitalization continues to reshape teaching and learning, building teachers' competence in technology-enabled action research will be essential to sustaining meaningful, data-informed improvements in science education.

ACKNOWLEDGEMENTS

This work was supported by the University of Science and Technology of Southern Philippines under an institutional grant.

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During the preparation of this work the authors used ChatGPT 4.0 in order to improve the English Language, consistency, and coherence in the manuscript. The authors declare that they reviewed and edited the final output as needed and takes full responsibility for the content of the published article.

REFERENCES

[1] I. Laudonia, R. Mamlok-Naaman, S. Abels, and I. Eilks, "Action research in science education—an analytical review of the literature," *Educ. Action Res.*, vol. 26, no. 3, pp. 480–495, May 2018, doi: 10.1080/09650792.2017.1358198.

[2] J. P. Marsh and D. Deibert, "Action research: Improving schools and empowering educators (book review)," *Impacting Educ.: J. Transform. Prof. Pract.*, vol. 7, no. 3, pp. 49–50, Aug. 2022, doi: 10.5195/ie.2022.239.

[3] M. P. E. Morales, "Participatory action research (PAR) cum action research (AR) in teacher professional development: A literature review," *Int. J. Res. Educ. Sci.*, vol. 2, no. 1, p. 156, Oct. 2015, doi: 10.21890/ijres.01395.
[4] S. Tan Cortes, "Needs assessment on action research competencies of teacher-researchers in Surigao del Sur, Philippines," *J. Educ. Innov.*, vol. 21, no. 4, pp. 1–19, 2019.
[5] S. Kemmis, R. McTaggart, and R. Nixon, *The Action Research Planner: Doing Critical Participatory Action Research*. Singapore: Springer, 2014, doi: 10.1007/978-981-4560-67-2.
[6] A. Oancea, N. Fancourt, J. Robson, I. Thompson, A. Childs, and N. Nuseibeh, "Research capacity-building in teacher education," *Oxf. Rev. Educ.*, vol. 47, no. 1, pp. 98–119, Jan. 2021, doi: 10.1080/03054985.2020.1842184.
[7] Department of Education, "Basic education enrollment and teacher profile statistics 2023," *DepEd Education Management Information System (EMIS)*. Accessed: Nov. 24, 2025. [Online]. Available: https://www.deped.gov.ph/resources/statistics/
[8] M. P. E. Morales, E. L. R. Abulon, P. Roxas-Soriano, A. P. David, M. V. C. Hermosisima, and M. G. Gerundio, "Examining teachers' conception of and needs on action research," *Issues Educ. Res.*, vol. 26, no. 3, 2016.
[9] M. Jr. Nicolas, S. S. Ignacio, and R. G. Bautista, "Action research attitude of teacher-researchers in a schools-district in Quirino Province, Philippines," *Int. J. Soc. Sci. Humanit.*, vol. 8, no. 2, pp. 106–117, 2023.
[10] S. Shaik-Abdullah, S. K. Suppiah Shanmugam, and M. Chinnappan, "Action research as continuous professional development in Southeast Asia," in *Oxford Research Encyclopedia of Education*, 2020, doi: 10.1093/acrefore/9780190264093.013.699.
[11] J. J. A. Idul *et al.*, "The LUNTIAN project: strengthening collaboration and sustainability mindset in the academic community through green chemistry integration," *J. Chem. Educ.*, Apr. 2025, doi: 10.1021/acs.jchemed.4c01380.
[12] E. Wenger, "Communities of practice: learning, meaning, and identity," *Syst. Thinker*, vol. 9, 1998, doi: 10.2277/0521663636.
[13] D. A. Schön, *The Reflective Practitioner: How Professionals Think in Action*. New York, NY, USA: Routledge, 2017, doi: 10.4324/9781315237473.
[14] C. M. D. Toquero, "'Real-world': Preservice teachers' research competence and research difficulties in action research," *J. Appl. Res. High. Educ.*, vol. 13, no. 1, pp. 126–148, Jan. 2021, doi: 10.1108/JARHE-03-2019-0060.
[15] W. A. Setiawan and P. Kuswandono, "Review of teachers' professional development research studies in Southeast Asia," *Int. J. Pedagogy Teach. Educ.*, vol. 4, no. 1, 2020, doi: 10.20961/ijpte.v4i1.33686.
[16] S. Tan Cortes and M. Jr. S. Reyes, "Challenges in conducting action research: experiences from biology teachers of a province in Mindanao, Philippines," *J. Pendidik. Progresif*, vol. 11, no. 2, pp. 151–164, 2021.
[17] J. J. A. Idul and A. M. P. Walag, "Integrating green chemistry and sustainability principles to a secondary science curriculum: A mixed-methods needs assessment," *J. Chem. Educ.*, vol. 101, no. 7, pp. 2765–2778, Jul. 2024, doi: 10.1021/acs.jchemed.4c00341.
[18] A. M. P. Walag, M. T. M. Fajardo, P. G. Bacarrisas, and F. M. Guimary, "A canonical correlation analysis of Filipino science teachers' scientific literacy and science teaching efficacy," *Int. J. Instr.*, vol. 15, no. 3, pp. 249–266, 2022.
[19] J. J. A. Idul *et al.*, "Green modules: integrating green and sustainable chemistry principles to secondary chemistry modules through process-oriented guided inquiry learning," *J. Chem. Educ.*, vol. 102, no. 3, pp. 1104–1116, Mar. 2025, doi: 10.1021/acs.jchemed.4c01360.
[20] C. Teddlie and F. Yu, "Mixed methods sampling: A typology with examples," *J. Mix. Methods Res.*, vol. 1, no. 1, 2007, doi: 10.1177/2345678906292430.
[21] T. H. Morris, "Experiential learning—a systematic review and revision of Kolb's model," *Int. J. Educ. Res.*, 2020, doi: 10.1080/10494820.2019.1570279.
[22] D. Akella, "Learning together: Kolb's experiential theory and its application," *J. Manage. Organ.*, vol. 16, no. 1, pp. 100–112, Mar. 2010, doi: 10.5172/jmo.16.1.100.
[23] M. Abdulwahed and Z. K. Nagy, "Applying Kolb's experiential learning cycle for laboratory education," *J. Eng. Educ.*, vol. 98, no. 3, pp. 283–294, Jul. 2009, doi: 10.1002/j.2168-9830.2009.tb01025.x.
[24] A. Bandura, *Self-Efficacy: The Exercise of Control*. New York, NY, USA: W. H. Freeman, 1997.
[25] A. M. P. Walag, M. T. M. Fajardo, F. M. Guimary, and P. G. Bacarrisas, "Science teachers' self-efficacy in teaching different K–12 science subjects: the case of Cagayan de Oro City, Philippines," *Science Int.*, vol. 32, no. 5, pp. 587–592, 2020.
[26] J. S. Sulonen, "Digital habitats: stewarding technology for communities," *J. Community Informatics*, vol. 9, no. 3, 2013, doi: 10.15353/joci.v9i3.3152.
[27] J. W. Creswell and V. L. Plano Clark, *Designing and Conducting Mixed Methods Research*, 3rd ed. Thousand Oaks, CA, USA: SAGE, 2017.
[28] M. D. Mertens, *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods*, 4th ed. Thousand Oaks, CA, USA: SAGE, 2019.
[29] N. K. Denzin and Y. S. Lincoln, *The SAGE Handbook of Qualitative Research*, 5th ed. Thousand Oaks, CA, USA: SAGE Publications, 2017. [Online]. Available: https://books.google.co.id/books/about/The_SAGE_Handbook_of_Qualitative_Researc.html?id=k2LgDQAAQBAJ&redir_esc=y.
[30] J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed. New York, NY, USA: Routledge, 1988. doi: 10.4324/9780203771587.
[31] D. G. Bonett and T. A. Wright, "Sample size requirements for estimating Pearson, Kendall and Spearman correlations," *Psychometrika*, vol. 65, no. 1, pp. 23–28, Mar. 2000, doi: 10.1007/BF02294183.
[32] J. Hauke and T. Kossowski, "Comparison of values of Pearson's and Spearman's correlation coefficients on the same sets of data," *Quaest. Geogr.*, vol. 30, no. 2, pp. 87–93, Jun. 2011, doi: 10.2478/v10117-011-0021-1.

[33] S. Tan Cortes, H. A. Pineda, and I. J. R. Geverola, "Examining competence in action research of basic education teachers in Cebu City, Philippines," *J. Nusantara Stud.*, vol. 6, no. 2, pp. 202–230, Jun. 2021, doi: 10.24200/jonus.vol6iss2pp202-230.

[34] J. K. Welch and M. Q. Patton, "Qualitative evaluation and research methods," *Mod. Lang. J.*, vol. 76, pp. 179–186, 1992, doi: 10.2307/330063.

[35] U. Sekaran and R. Bougie, *Research Methods for Business: A Skill-Building Approach*, 7th ed. Hoboken, NJ, USA: Wiley, 2016. [Online]. Available: https://books.google.co.id/books?id=Ko6bCgAAQBAJ.

[36] M. Kendrach, "Biostatistics: the bare essentials," *Am. J. Health-Syst. Pharm.*, vol. 54, no. 2, 1997, doi: 10.1093/ajhp/54.2.223.

[37] V. Braun and V. Clarke, "One size fits all? What counts as quality practice in (reflexive) thematic analysis?," *Qual. Res. Psychol.*, vol. 18, no. 3, 2021, doi: 10.1080/14780887.2020.1769238.

[38] I. Laudonia and I. Eilks, "Reflections on a three-year-long teacher-centered, participatory action research experience on teaching chemical bonding in a Swiss vocational school," *Educ. Sci.*, vol. 8, no. 3, pp. 141–156, Sep. 2018, doi: 10.3390/educsci8030141.

[39] N. Behnamnia and S. Hayati, "Enhancing teacher confidence and competence: A case study of digital research skills training," *E-Learn. Digit. Media*, Mar. 2025, doi: 10.1177/20427530251331085.

[40] M. Wyatt, "Towards a re-conceptualization of teachers' self-efficacy beliefs: tackling enduring problems with the quantitative research and moving on," *Int. J. Res. Method Educ.*, vol. 37, no. 2, 2014, doi: 10.1080/1743727X.2012.742050.

[41] M. A. Flores, "Learning to be a teacher: Mentoring, collaboration and professional practice," *J. Educ. Teach.*, 2019, doi: 10.1080/02619768.2019.1680207.

[42] F. Patrick, D. Elliot, M. Hulme, and A. McPhee, "The importance of collegiality and reciprocal learning in the professional development of beginning teachers," *J. Educ. Teach.*, vol. 36, no. 3, 2010, doi: 10.1080/02607476.2010.497373.

[43] M. Grangeat and P. Gray, "Factors influencing teachers' professional competence development," *J. Vocat. Educ. Train.*, vol. 59, no. 4, 2007, doi: 10.1080/13636820701650943.

[44] S. Gordon, "Integrating the experiential learning cycle with educational supervision," *J. Educ. Supervision*, vol. 5, no. 3, pp. 1–34, Dec. 2022, doi: 10.31045/jes.5.3.1.