

# **Teacher Competency, Professional Development, and Technology Integration in Curriculum Reform: A Systematic Review of Quantitative Evidence**

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**PICOS review questions:**

- a. How do professional development initiatives quantitatively influence teacher competency in implementing curriculum reforms?
- b. In what measurable ways does teacher competency affect the quantitative outcomes of technology integration in curriculum delivery during curriculum reform?
- c. What are the statistically significant relationships between teachers' participation in professional development programs and their readiness to adopt technology in the context of curriculum reform?
- d. Which teacher populations (elementary, secondary, or tertiary) are most frequently represented in quantitative studies on competency, professional development, and technology integration, and how are these samples characterized?

- e. Which forms of professional development (e.g., workshops, online training, mentoring) show the strongest quantitative effects on teacher competency and technology integration within curriculum reform settings?
- f. How do contextual factors such as institutional support, access to resources, and policy environments quantitatively mediate or moderate the relationship between teacher competency and technology integration during curriculum reform?
- g. What theoretical or technological frameworks (e.g., TPACK, SAMR, Technological Pedagogical Knowledge models) are most commonly applied in quantitative research to assess teacher competency and technology integration in curriculum reform?
- h. What quantitative instruments and measures demonstrate strong reliability and validity in assessing teacher competency, professional development outcomes, and technology integration during curriculum reform?

**Primary review objective/s**

- a. To synthesize quantitative evidence on how professional development initiatives influence teacher competency and technology integration within the context of curriculum reform.
- b. To determine the measurable relationships among teacher competency, professional development participation, and readiness to adopt technology during curriculum reform.

**Secondary review objective/s**

- a. To identify the demographic and contextual patterns (e.g., education level, institutional support, resource access) represented in quantitative studies examining teacher competency, professional development, and technology integration in curriculum reform.
- b. To review the theoretical frameworks and quantitative instruments most commonly employed to assess teacher competency, professional development outcomes, and technology integration in curriculum reform studies.

## **1. RATIONALE**

The contemporary educational landscape is continuously reshaped by curriculum reforms, demanding a highly skilled and adaptive teaching profession. The successful implementation of these reforms hinges critically on robust teacher competency, effective professional development initiatives, and the seamless integration of technology into pedagogical practices. This systematic review, titled "Teacher Competency, Professional Development, and Technology Integration in Curriculum Reform: A Systematic Review of Quantitative Evidence," endeavors to synthesize quantitative literature to elucidate the intricate relationships among these pivotal elements.

Curriculum reforms inevitably introduce new content, pedagogical approaches, and technological demands, compelling educators to evolve their teaching methods (El-Hamamsy et al., 2024). Teachers are undeniably central to the digitalization of education, rendering continuous professional development in this domain not just beneficial, but indispensable (Wohlfart & Wagner, 2023). Often, educators may lack the necessary skills and confidence to effectively incorporate technology into their classrooms, thereby underscoring the critical need for well-designed technology-related professional development programs to bridge this competency gap (Siyam et al., 2025). Consequently, understanding the quantitative influence of PD initiatives on teacher competency in implementing curriculum reforms emerges as a primary focus of this review, directly addressing PICOS review question 1. The ongoing need for support and training, particularly for primary school teachers, is further highlighted by the imperative for them to develop new competencies in response to digital transformation (Stumbrienė et al., 2024).

Effective PD programs are foundational for cultivating the teacher capacity and competence essential for the enduring success of curricular reforms (El-Hamamsy et al., 2024). Such programs should ideally encompass not only hands-on technology training but also emphasize pedagogical alignment, foster collaborative learning among educators, and provide sustained support (Napitupulu et al., 2025). Research further reveals a diverse array of

PD approaches and considerations, which are often influenced by policy, culture, and specific school contexts (Thurm et al., 2023).

The integration of technology in education extends far beyond the mere adoption of tools; it represents a fundamental shift towards transforming learning experiences to prepare students for an increasingly technologically advanced world (Siyam et al., 2025). Conceptual frameworks like Technological Pedagogical Content Knowledge and the Substitution, Augmentation, Modification, Redefinition model offer invaluable guidance for understanding effective technology integration (Siyam et al., 2025). TPACK, in particular, explicitly underscores the intertwined nature of content, pedagogical, and technological knowledge (Siyam et al., 2025; Özden et al., 2024), enjoying significant empirical backing as a model for developing preservice teachers' digital competencies and widespread international acceptance (Özden et al., 2024; Wohlfart & Wagner, 2023). The SAMR model further delineates varying levels of technology integration, spanning from basic substitution to genuinely transformative educational practices (Siyam et al., 2025). Importantly, effective technology integration is directly contingent upon teacher competency. PICOS review question 2 specifically seeks to quantify how teacher competency impacts the outcomes of technology integration in curriculum delivery, given that teacher self-efficacy is a significant predictor of technology use and integration efforts (Gomez et al., 2022). Consequently, elucidating the statistically significant relationships between teachers' participation in PD programs and their readiness to adopt technology during curriculum reform (PICOS review question 3) is paramount for designing impactful interventions, including understanding the motivations that drive teachers to transfer technology-enabled educational innovation (Stumbrienė et al., 2024).

While a considerable body of literature addresses teacher professional development and technology integration, a focused systematic review of quantitative evidence within the context of curriculum reform is both timely and essential. This review aims to synthesize this evidence to address several critical gaps, fulfilling two primary objectives: first, to synthesize quantitative evidence on how professional development initiatives influence teacher

competency and technology integration within the context of curriculum reform (addressed by PICOS Q1 and Q5) and second, to determine the measurable relationships among teacher competency, professional development participation, and readiness to adopt technology during curriculum reform (addressed by PICOS Q2 and Q3). This second objective aims to unravel the intricate connections among these factors, providing a clearer understanding of their collective contribution to successful reform implementation, with longitudinal studies being particularly valuable for understanding teachers' trajectories of technology integration during PD (Fütterer et al., 2024).

Furthermore, the review pursues two secondary objectives: to identify the demographic and contextual patterns (e.g., education level, institutional support, resource access) represented in quantitative studies examining teacher competency, professional development, and technology integration in curriculum reform. This objective directly relates to PICOS review question 4 regarding teacher populations and PICOS review question 6, which explores how contextual factors mediate or moderate these relationships, offering vital insights into the generalizability of findings. Institutional support, access to resources, and policy environments are known to significantly influence the sustainability of digital education reforms (El-Hamamsy et al., 2024) and the effectiveness of PD can also be influenced by these contextual factors (Fütterer et al., 2024). The second secondary objective is to review the theoretical frameworks and quantitative instruments most commonly employed to assess teacher competency, professional development outcomes, and technology integration in curriculum reform studies, informed by PICOS review questions 7 and 8. The TPACK framework, for instance, is widely accepted for understanding teacher knowledge related to technology integration (Wohlfart & Wagner, 2023; Jiménez Sierra et al., 2023; Harris et al., 2017). Numerous assessment tools have been developed to measure teacher digital literacy and competence, emphasizing their reliability and validity (Nguyen & Habók, 2023; Tzafilkou et al., 2023; Christensen & Knezek, 2017; Fegely et al., 2023), and this review will critically examine these instruments, thereby contributing to methodological rigor in future research.

The digital competencies of university teachers, for example, represent an imperative requirement in the 21st century (Saltos-Rivas et al., 2023).

In conclusion, this systematic review is meticulously designed to offer a robust quantitative synthesis of the interplay among teacher competency, professional development, and technology integration within the dynamic context of curriculum reform. By diligently addressing the specified PICOS questions and objectives, it aims to furnish actionable insights for policymakers, curriculum developers, and educators. The ultimate goal is to contribute to more effective and sustainable educational transformations in the digital age, consolidating existing knowledge and highlighting promising avenues for future research, particularly concerning the long-term impact of PD and the identification of optimal forms of professional development.

### **1.1 Description of the issue under consideration**

The issue under consideration is the growing complexity of implementing curriculum reforms in an era increasingly defined by digital transformation. As education systems worldwide undergo curricular restructuring to integrate 21st-century competencies, technology, and innovative pedagogical approaches, teachers are expected to assume new roles that demand advanced competencies, adaptability, and continuous professional growth. However, many teachers face challenges in aligning their pedagogical practices with emerging curriculum requirements and digital technologies (El-Hamamsy et al., 2024).

Curriculum reforms typically introduce new content standards, teaching methodologies, and expectations for technology integration. These changes often outpace teachers' preparedness, resulting in uneven implementation and variable student outcomes (Wohlfart & Wagner, 2023). While technology has become an integral part of education, its effective integration relies heavily on teachers' digital competencies and self-efficacy (Siyam et al., 2025). Unfortunately, research indicates that many educators, particularly in primary and secondary education, lack sufficient training, confidence, and institutional support to successfully embed technology into their pedagogical practice (Stumbrienė et al., 2024).

Consequently, the central issue this review addresses is the quantitative relationship among teacher competency, professional development, and technology integration within the context of curriculum reform. Understanding these interrelated factors is essential to ensuring that curriculum reforms lead to meaningful, sustainable improvements in teaching and learning outcomes rather than superficial changes in policy or technology use.

## **1.2 Description of the Intervention**

The primary intervention examined in this review is teacher professional development (PD) aimed at enhancing teacher competency and technology integration in curriculum reform contexts. Professional development represents an organized, intentional process designed to improve teachers' knowledge, skills, and practices, enabling them to meet evolving curricular and technological demands.

PD initiatives may take various forms, including workshops, mentoring, peer collaboration, online courses, blended learning programs, and long-term training modules (Napitupulu et al., 2025). These interventions are often structured around pedagogical frameworks such as Technological Pedagogical Content Knowledge (TPACK) and the Substitution, Augmentation, Modification, Redefinition (SAMR) model (Siyam et al., 2025). Both frameworks provide conceptual guidance for integrating technology meaningfully into teaching practice.

In this context, the intervention involves not only training teachers in digital tools and pedagogical applications but also fostering deeper conceptual understanding of how technology aligns with curriculum goals. High-quality PD interventions also emphasize continuous support, reflection, and collaboration, ensuring that teachers transfer acquired skills into their classrooms effectively (Fütterer et al., 2024).

Thus, the professional development intervention serves as a strategic mechanism to build teacher competency and confidence, enabling educators to effectively implement curriculum reforms that are technologically and pedagogically sound.

### **1.3 How the Intervention Might Work**

Professional development initiatives are expected to work through multiple interrelated mechanisms that enhance teachers' competency, self-efficacy, and instructional practices. First, by providing structured opportunities for learning and reflection, PD programs can strengthen teachers' technological, pedagogical, and content knowledge as conceptualized in the TPACK framework (Wohlfart & Wagner, 2023; Özden et al., 2024). This integration of knowledge domains enables teachers to make informed pedagogical decisions regarding when and how to use technology to support learning objectives.

Second, PD interventions can enhance teachers' self-efficacy—their belief in their ability to successfully integrate technology and adapt to new curricular requirements (Gomez et al., 2022). Increased self-efficacy has been shown to predict more consistent and innovative technology use in classroom instruction.

Third, collaborative and sustained PD models facilitate peer learning and professional communities, allowing teachers to share best practices, troubleshoot challenges, and collectively navigate curricular changes (Thurm et al., 2023). Moreover, contextual supports such as administrative leadership, access to digital resources, and institutional policies can mediate or moderate the effectiveness of these interventions (El-Hamamsy et al., 2024; Fütterer et al., 2024).

Overall, the intervention works by equipping teachers not only with technical proficiency but also with adaptive expertise—enabling them to align digital tools, pedagogical strategies, and curriculum goals for improved student learning outcomes.

### **1.4 Why It Is Important to Do This Review**

Conducting this systematic review is important for several interrelated reasons. Despite the abundance of research on teacher professional development and technology integration, there remains a lack of synthesized quantitative evidence that explicitly connects these

constructs within the context of curriculum reform. Existing studies vary in scope, methodological rigor, and measurement instruments, creating fragmented insights into how professional development influences teacher competency and, in turn, technology integration outcomes.

By systematically reviewing and analyzing quantitative data, this study aims to clarify the magnitude and direction of these relationships, identifying which PD approaches, contextual factors, and theoretical frameworks most effectively support teacher growth and reform implementation. This is particularly critical as educational systems worldwide continue to invest substantial resources in digital transformation and teacher training programs without a clear understanding of their measurable impacts (Fütterer et al., 2024; Lawless & Pellegrino, 2007).

Furthermore, this review will identify reliable quantitative instruments and validated models (e.g., TPACK, SAMR) that can guide future research and policy development (Nguyen & Habók, 2024; Tzafilkou et al., 2023). It will also provide evidence-based insights for policymakers, curriculum designers, and education leaders seeking to align professional development with curricular goals and technological innovations.

Ultimately, the review is significant because it addresses an urgent need to bridge the gap between educational policy and classroom practice. By understanding how teacher competency, professional development, and technology integration interact quantitatively during curriculum reform, stakeholders can design more targeted, effective, and sustainable interventions that truly enhance teaching and learning in the digital age.

## **2. Inclusion and Exclusion Criteria**

The eligibility criteria define the boundaries of the systematic review. They are derived directly from the PICOS framework and specify the characteristics that a study must possess to be included in the synthesis. Any study failing to meet these standards will be excluded.

## 2.1 PICOS-Based Eligibility Criteria

<b>Domain</b>	<b>Inclusion (Studies MUST meet these specific criteria)</b>	<b>Exclusion (Specific research types NOT suitable for this review)</b>
<b>Population/s</b>	<ul style="list-style-type: none"> <li>- Teachers at the elementary, secondary, or tertiary levels.</li> <li>- Participants involved in curriculum reform, curriculum implementation, or technology-supported instruction.</li> <li>- Teachers are the primary respondents or units of analysis.</li> </ul>	<ul style="list-style-type: none"> <li>- Studies focused solely on students, parents, administrators, or non-teaching personnel.</li> </ul>
<b>Intervention/s</b>	<ul style="list-style-type: none"> <li>- Structured professional development (PD), training programs, workshops, or mentoring aimed at developing teacher competency and technology integration related to curriculum reform.</li> </ul>	<ul style="list-style-type: none"> <li>- Interventions completely unrelated to teacher competency development, technology use, or curricular changes.</li> </ul>
<b>Comparator/s</b>	<ul style="list-style-type: none"> <li>- Studies that provide comparisons (e.g., pre/post, intervention/control group, different PD types) or relational data suitable for statistical testing.</li> </ul>	<ul style="list-style-type: none"> <li>- Studies that are purely descriptive, lacking any form of comparison or inferential statistical testing.</li> </ul>
<b>Outcome/s</b>	<ul style="list-style-type: none"> <li>- Studies reporting quantitative measures (numerical data) of teacher competency, PD outcomes, or technology integration/readiness.</li> <li>- Data must be extractable for quantitative synthesis (e.g., means, correlations, effect sizes).</li> </ul>	<ul style="list-style-type: none"> <li>- Studies providing qualitative findings only.</li> </ul>
<b>Study Design (S)</b>	<ul style="list-style-type: none"> <li>- Quantitative primary research (correlational, quasi-experimental, experimental, or advanced survey-based methods).</li> <li>- Publications in peer-reviewed journals or academic dissertations.</li> </ul>	<ul style="list-style-type: none"> <li>- Systematic Reviews, Meta-Analyses, Scoping Reviews, Commentaries, Editorials, or Conceptual/Policy Papers.</li> </ul>

## 2.2 Three-Stage Screening Process

### Stage 1: Initial Screening (Eligibility Stage)

All retrieved articles must meet all of the following quantitative eligibility criteria to proceed to the Quality Appraisal Stage.

Criterion	Description
<b>Research Design</b>	Is the study a primary research article employing a quantitative research design (e.g., correlational, quasi-experimental, survey-based)?
<b>Variables</b>	Does the study quantitatively measure at least one of the following core variables: teacher competency, professional development (PD), or technology integration within the context of curriculum reform?
<b>Instruments</b>	Does the study use quantitative instruments such as surveys, standardized tests, or observational rating scales that produce numerical data?
<b>Quantification and Scoring</b>	Does the study report numerical data with a clear description of how the variables were scored or quantified?
<b>Data Analysis</b>	Does the study use statistical analysis techniques (e.g., correlation, regression, ANOVA, $t$ -tests) to analyze the data?
<b>Population</b>	Does the study's population include Elementary, secondary or tertiary level teachers?

### Stage 2: Quality Appraisal Stage

Articles that pass the initial screening will be evaluated for methodological quality using the Scoring Rubric below. A score is assigned for each criterion, with a minimum total score required for inclusion.

Criteria (PICOS)	3 Points (Excellent)	2 Points (Good)	1 Point (Fair)
<b>Sufficient Data</b>	Provides all necessary statistical data for synthesis, including means, standard deviations, correlations, and/or effect sizes in a clear, extractable format. All key variables	Provides most of the key data but some is missing or requires calculation. The primary findings on outcomes are still evident and usable.	Provides very little key data, with most findings presented narratively, making them difficult to synthesize.

	are numerically represented.		
<b>Contextual Clarity</b>	Clearly and comprehensively describes the Population (e.g., specific grade level, teacher experience), the Intervention (e.g., type, duration, and content of PD), and the Context (e.g., specific curriculum reform, type of technology).	Describes most aspects of the context, but with some details missing. The population, PD, and technology are largely understandable.	Mentions the context but provides very little detail, making it difficult to fully understand the study's setting and variables.
<b>Theoretical Framework</b>	Explicitly names and uses a specific framework (e.g., TPACK, SAMR) to guide the research design, data collection, and/or analysis. The framework's connection to the study is well-explained.	Mentions a framework in passing or uses a similar but unstated approach that is clearly recognizable.	Vaguely alludes to a theoretical foundation without a specific framework or clear connection to the study's design.
<b>Methodological Rigor</b>	Employs a robust study design. Uses validated, reliable instruments and appropriate statistical analysis. The methodology is well-described and replicable.	Uses instruments of unclear validity or has minor methodological flaws (e.g., a slightly small sample size) that do not invalidate the findings.	Has significant methodological flaws (e.g., extremely small sample size, no comparison group in an intervention study) that seriously limit the reliability of the findings.

### Stage 3: Final Inclusion Stage

Only studies that meet the inclusion threshold—a total score of 6 and higher from the Quality Appraisal—are selected for final integration into the systematic review.

Total Score	Decision	Reason
6 and Higher	Include	The study demonstrates acceptable methodological rigor and provides adequate data relevant to the review. A score of 6 or above indicates that the study meets the minimum quality standards in terms of design, data collection, and analysis. Including these studies ensures that the review captures sufficient, reliable evidence while maintaining scientific credibility and representativeness.
Below 6	Exclude	The study exhibits notable methodological weaknesses or insufficient data that may compromise the validity of the review’s findings. Low-scoring studies often lack methodological soundness—such as unclear research design, weak instruments, or incomplete data—which could lead to biased or unreliable conclusions. Excluding them upholds the quality and integrity of the review.

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