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Teachers' Familiarity, Readiness, and Anticipated Benefits and Barriers of Generative AI in Design and Technology Education

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ABSTRACT

The rapid advancement of generative artificial intelligence (GenAI) raises pressing questions about teacher readiness to integrate emerging technologies into classroom practice, particularly in Design and Technology education, where creativity and project-based learning are central. This study investigates teachers' familiarity, readiness, and perceptions of GenAI following a targeted professional development workshop. A mixed-methods survey of 147 in-service teachers combined Likert-scale items with open-ended responses. Quantitative results indicated strong readiness and high perceived benefits, especially for fostering creativity, enhancing student engagement, and supporting project-based work. Correlation analysis showed that readiness was closely associated with perceived benefits, while barriers were less influential. Thematic analysis of open-ended responses highlighted four themes: pedagogical benefits, opportunities for professional growth, barriers to long-term adoption, and recommendations for sustained implementation. Overall, the findings reveal both enthusiasm and caution among teachers. While positive attitudes provide strong momentum for adoption, sustainable classroom integration will require institutional support, iterative and context-specific professional development, and clear policy guidance. This study contributes empirical insights into GenAI in education and offers practical implications for bridging teacher readiness with enduring classroom practice.

Keywords: Generative Artificial Intelligence, Teacher Readiness, Professional Development, Design and Technology Education, AI Integrated Learning

INTRODUCTION

The rapid progression of artificial intelligence (AI) has reshaped industries, economies, and educational systems across the globe. Among its diverse forms, Generative AI (GenAI), which includes large language models, image generation tools, and multimodal systems, stands out as a particularly transformative innovation (Dwivedi et al., 2023; Zhang & Aslan, 2021). Unlike earlier AI technologies focused primarily on automation and prediction, GenAI can produce original outputs such as text, images, code, and designs, thereby broadening the scope of creative and knowledge-driven activities. In education, GenAI is increasingly valued as a means to enhance personalization, stimulate creativity, and introduce new ways for students to engage deeply with learning (Kasneci et al., 2023; Zawacki-Richter et al., 2019). These shifts call for a fresh evaluation of the role teachers play not only as facilitators of student learning but also as continuous learners adapting to evolving technologies.

Worldwide, there is growing momentum to integrate GenAI into educational settings. Recent research indicates that GenAI can improve project-based learning, facilitate differentiated instruction, and help scaffold idea generation for student projects (Cotton et al., 2023; Holmes et al., 2022). These capabilities align strongly with the aims of Design and Technology (D&T) education, which focuses on problem-solving, innovation, and prototyping. D&T classrooms offer an ideal environment for exploring GenAI applications, ranging from aiding students in creating design concepts to supporting iterative prototyping and research activities. However, despite this promise, there is still limited empirical data on teachers'

perceptions and adoption of GenAI within specific subjects such as D&T (Moundridou & Matzakos, 2025).

Understanding how teachers adopt GenAI requires engagement with established frameworks of technology adoption and teacher learning. The Technology Acceptance Model (TAM) (Davis, 1989) highlights the role of perceived usefulness and ease of use in shaping user intentions. In educational contexts, teachers' beliefs about whether GenAI tools can enhance student learning (usefulness) and whether they are manageable to integrate into practice (ease of use) are likely to influence adoption. The Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2009; Lakhe Shrestha et al., 2025), complements this view by emphasizing the interplay among teachers' subject expertise, pedagogical strategies, and technological competence. In Design and Technology education, effective GenAI use requires teachers not only to operate AI tools but also to align them with design pedagogies and content-specific goals such as creativity, prototyping, and problem-solving. Parallel research on teacher professional development underscores that clarity of purpose, subject relevance, and opportunities for practice are essential for fostering technology adoption (Desimone, 2009; Kaplan-Rakowski et al., 2023). Together, these frameworks justify examining teachers' familiarity, readiness, benefits, and barriers as key constructs in understanding adoption trajectories (Nyaaba & Zhai, 2024).

As AI technologies progress at an unprecedented rate, the need for teacher upskilling in AI literacy has become increasingly critical. Researchers emphasize that the success of AI adoption in education relies more on teachers' capacity to meaningfully leverage the technology than on the technology itself (Luckin, 2023). Without sufficient training, teachers may either underuse new tools or employ them in ways that do not align with pedagogical goals. Professional development plays a vital role in closing the gap between technological possibilities and classroom practice. Effective professional development not only provides teachers with technical expertise but also offers pedagogical frameworks for responsible implementation, while addressing ethical and infrastructure-related issues (MacDowell et al., 2024). Specifically for generative AI, focused professional development programs are crucial to help teachers move beyond mere familiarity toward confident, context-appropriate integration.

In the fields of design and technology (sometimes called technology and engineering), researchers are actively exploring how to integrate generative GenAI into creative and educational practices. Empirical studies demonstrate that tools like ChatGPT and Midjourney can aid designers by quickly translating ideas into visual models, which reduces the time and effort required for traditional sketching and ideation (Byrne et al., 2025; Chen et al., 2025). This technology acts as a collaborator, helping designers define problems and generate ideas by expanding the solution space and providing various stimuli (Chen et al., 2025). Researchers have applied GenAI to diverse tasks, from designing speculative products to creating instructions for computer-aided design (CAD) models (Byrne et al., 2025; Vartiainen et al., 2025). GenAI is also being used as a teaching and learning method, creating personalized and interactive environments that foster key skills like originality, digital fluency, and problem-solving (Abdelmagid et al., 2025; Hamed, 2025). A core theme across these studies is that while GenAI can handle complex tasks, the human role remains critical for analysis, evaluation, and final decision-making, establishing a new model of human-AI collaboration in the design process (Vartiainen et al., 2025).

Despite enthusiasm for GenAI, several barriers complicate adoption. Ethical concerns about plagiarism and academic honesty are among the most widely cited (Creely, 2024). Teachers also highlight infrastructure and policy gaps, noting that schools often lack the

technological readiness or institutional guidance to support meaningful AI integration (Al-Shahri & Mudhsh, 2025). Furthermore, many teachers emphasize the need for subject-specific examples and sustained training to ensure classroom relevance (Holmes et al., 2022). Without systemic support, even motivated teachers may struggle to integrate GenAI effectively. These challenges underscore the importance of situating teacher perspectives at the center of research and policymaking.

Although discourse on AI in education is rapidly expanding, most scholarship continues to emphasize broad opportunities and systemic risks rather than the realities of classroom integration (Dwivedi et al., 2023; Zawacki-Richter et al., 2019). In particular, empirical evidence on teachers' perceptions of GenAI following structured professional development remains scarce, especially within subject-specific domains such as Design and Technology. This study addresses that gap by examining teachers' familiarity with GenAI, their readiness to integrate it, their perceptions of its pedagogical benefits, and the barriers they anticipate. Grounded in frameworks such as the Technology Acceptance Model (TAM) and Technological Pedagogical Content Knowledge (Koehler & Mishra, 2009; Ghimire & Edwards, 2024), the study contributes to both theory and practice by extending technology adoption research into the emerging context of GenAI in D&T education and by offering insights to guide the design of PD and policy strategies that support responsible AI integration in schools.

Based on this context and theoretical framework, this study aims to address three key aspects regarding teachers' adoption of GenAI. First, the research will investigate teachers' prior levels of familiarity with and experience in using GenAI before the professional development, establishing a baseline for their initial knowledge. Second, the study will explore teachers' subjective readiness to integrate GenAI into Design and Technology instruction following the training, reflecting their beliefs and behavioral intentions. Third, the research will identify the pedagogical benefits teachers anticipate, as well as the practical and ethical challenges they foresee in implementing GenAI within classroom practice, thereby providing a holistic picture of their perceptions toward integrating this new technology.

METHODS OF RESEARCH

Research Design

This study adopted a mixed-methods survey design to investigate teachers' familiarity, readiness, perceived benefits, and anticipated barriers in adopting Generative AI (GenAI) within Design and Technology education. The quantitative strand generated measurable insights into teachers' attitudes and levels of preparedness, while the qualitative strand provided richer accounts of their perspectives and contextual experiences, ensuring a more comprehensive understanding of the phenomenon (Creswell & Plano Clark, 2011).

Participants

The study involved 147 in-service Thai teachers across multiple subject areas. Participants were selected using purposive sampling. The criteria for inclusion were that participants must be in-service teachers currently employed at the basic education level and must have completed the professional development workshop on GenAI prior to the survey. The majority taught Computational Science (122 teachers; 83.0%) and Design and Technology (118 teachers; 80.3%), while smaller groups reported teaching Science (17 teachers; 11.6%), Mathematics (10 teachers; 6.8%), and other subjects (21 teachers; 14.3%). This distribution reflects the workshop's emphasis on computational and design-oriented pedagogy. Teaching experience varied widely, representing both early-career and master educators. The largest group had 5–10 years of experience (45 teachers; 30.6%), followed by 11–15 years (31

teachers; 21.1%), less than 5 years (27 teachers; 18.4%), 16–20 years (24 teachers; 16.3%), and more than 20 years (20 teachers; 13.6%). This suggests a balanced mix of novice and experienced teachers.

Data Collection and Analysis

Data were collected immediately following a three-hour professional development workshop on Generative AI in Design and Technology education. The workshop introduced participants to a range of GenAI tools, including large language models, image generators, and multimodal applications, and provided opportunities for hands-on engagement with design-oriented tasks. Participants also engaged in collaborative reflection on potential classroom applications within the D&T curriculum. Ethical considerations were explicitly addressed, with discussion on how teachers might establish guidelines for responsible student use of GenAI. At the conclusion of the session, participants completed an online survey administered through Google Forms.

The survey instrument was voluntary, anonymous, and designed to be completed within approximately ten minutes to encourage candid participation while minimizing burden. Content validity of the instrument was assessed by three experts in educational technology and curriculum design, who reviewed the items for clarity and relevance. Minor adjustments were made to the wording based on their feedback prior to distribution. As noted in Table 2, the reliability of the scales was confirmed with Cronbach's alpha coefficients ranging from .83 to .91. It comprised both quantitative and qualitative measures. The quantitative component included fifteen Likert-scale items (1 = Strongly Disagree to 5 = Strongly Agree), grouped into three scales: Readiness (4 items), Perceived Benefits (6 items), and Barriers (5 items), all adapted from established instruments on teacher technology adoption and AI integration. Additionally, a single-item measure was included to assess prior Familiarity: "Please rate your level of familiarity with Generative AI tools prior to this workshop" (1 = Not at all familiar to 5 = Very familiar). The qualitative component consisted of one open-ended item that invited participants to elaborate on perceived opportunities and challenges of incorporating GenAI into Design and Technology classrooms, providing contextual depth and enabling triangulation with the quantitative findings. This design anchored participants' perceptions in a shared practical context, thereby enhancing the ecological validity of the study. Table 1 summarizes the item wordings and their scale membership.

Table 1 Survey Items Grouped into Readiness, Benefits, and Barriers Scales

Scale	Item wording
Readiness	I am confident I can self-study to learn Generative AI. I am willing to try using Generative AI in my class. I feel comfortable learning new technologies such as Generative AI. I have adequate skills to begin using Generative AI.
Benefits	Generative AI makes Design & Technology learning more engaging. Generative AI supports student projects. Generative AI provides research support for projects. Generative AI helps idea generation for D&T activities. Generative AI promotes students' critical thinking. Generative AI supports personalized learning.
Barriers	I need subject-specific examples for applying Generative AI. I need further training to use Generative AI effectively. I have concerns about academic honesty when using Generative AI. I have ethical concerns about students' use of Generative AI. School or policy infrastructure is not yet ready for Generative AI adoption.

To ensure the reliability of the measurement scales, internal consistency was examined using Cronbach's alpha based on responses from 147 participants. Table 2 presents the internal consistency coefficients alongside the descriptive statistics for the key scales.

Table 2 Internal Consistency and Descriptive Statistics of Key Scales

Scale	α	M	SD
Readiness	.87	4.61	0.44
Benefits	.91	4.72	0.41
Barriers	.83	4.27	0.64

RESULTS AND DISCUSSION

Quantitative results

Teachers reported a high level of readiness to integrate Generative AI, with a composite readiness score of 4.61 (SD = 0.44) on a 5-point scale. Among individual items, the highest rating was for comfort with learning new technologies (M = 4.67, SD = 0.47), followed closely by willingness to experiment with GenAI in the classroom (M = 4.64, SD = 0.48). All readiness items scored above 4.5, indicating consistently strong preparedness across the scale as shown in table 3.

Table 3 Descriptive Statistics for the Readiness Scale

Readiness Item	Mean	SD
Confidence to self-study	4.58	0.52
Willingness to try in class	4.64	0.48
Comfort with learning new technologies	4.67	0.47
Adequate skills to begin using GenAI	4.56	0.52

Table 4 Descriptive Statistics for the Benefit Scale

Benefit Item	Mean	SD
Makes D&T learning engaging	4.77	0.44
Supports student projects	4.73	0.44
Research support for projects	4.72	0.46
Idea generation for DT activities	4.71	0.45
Promotes critical thinking	4.69	0.49
Supports personalized learning	4.67	0.51

As presented in table 4, teachers expressed strong agreement regarding the benefits of Generative AI in Design and Technology instruction, with a composite benefits score of 4.72 (SD = 0.41) on a 5-point scale. The highest-rated benefit was the potential of GenAI to make D&T learning more engaging (M = 4.77, SD = 0.44), followed by its value in supporting student projects (M = 4.73, SD = 0.44) and providing research assistance (M = 4.72, SD = 0.46). All benefit items exceeded 4.6, reflecting highly positive expectations for the role of GenAI in enriching student learning experiences.

Table 5 Descriptive Statistics for the Barrier Scale

Barrier Item	Mean	SD
Need subject-specific examples	4.73	0.49
Need for further training	4.71	0.51
Academic honesty concerns	4.10	0.98
Ethical concerns	4.01	1.06
Policy/infrastructure readiness	3.80	1.23

In table 5, teachers identified several barriers to integrating Generative AI, with the most pressing concerns relating to the need for subject-specific examples (M = 4.73, SD = 0.49)

and additional training ($M = 4.71$, $SD = 0.51$). Concerns about academic honesty ($M = 4.10$, $SD = 0.98$) and ethical issues ($M = 4.01$, $SD = 1.06$) were also salient, while policy and infrastructure readiness was rated comparatively lower ($M = 3.80$, $SD = 1.23$). The composite barriers score averaged 4.27 ($SD = 0.64$), suggesting that although teachers hold highly positive views of GenAI, they also foresee significant challenges that will require targeted support and institutional resources.

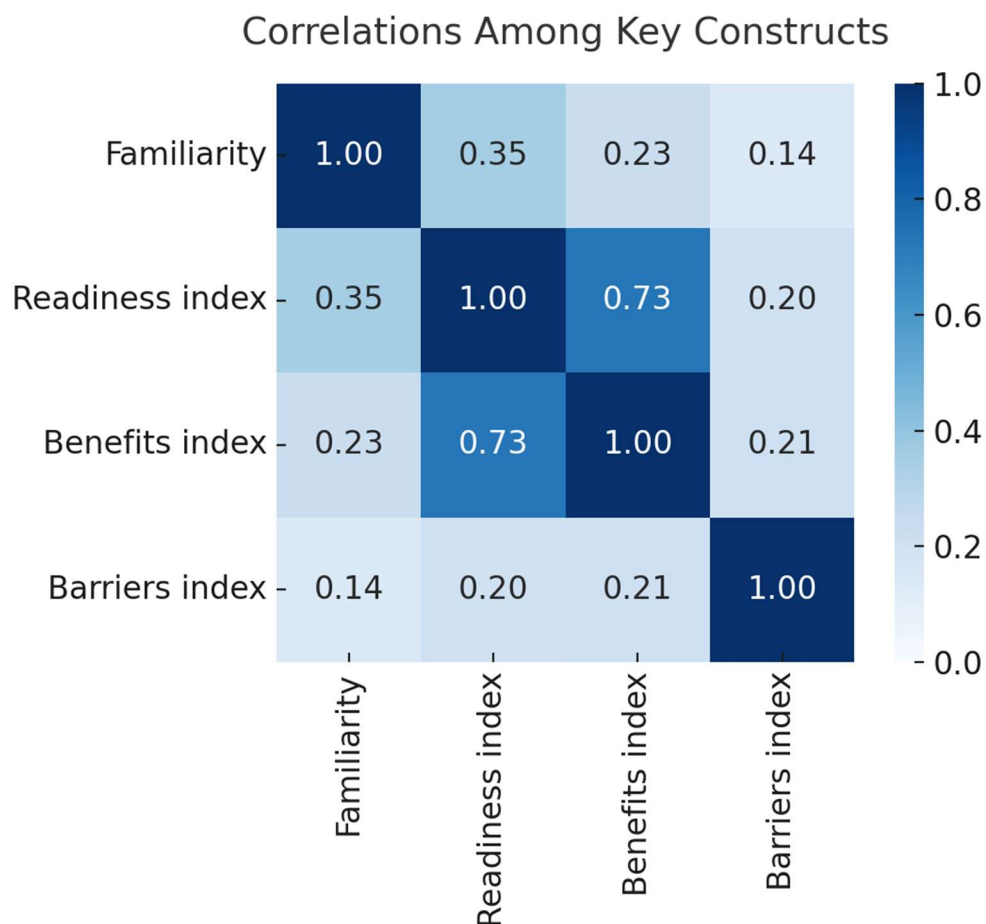


Figure 1. Correlation heatmap of teachers' familiarity with Generative AI, readiness to integrate it, perceived benefits, and perceived barriers.

Figure 1 presents the correlations among the four key constructs: familiarity with Generative AI, readiness to integrate it, perceived benefits, and perceived barriers. The heatmap illustrates that the strongest association was between readiness and perceived benefits ($r = .73$), indicating that teachers who felt more ready to use Generative AI also tended to perceive greater pedagogical value in it. Familiarity with Generative AI prior to training showed a moderate positive correlation with readiness ($r = .35$) and a weaker association with benefits ($r = .23$), suggesting that prior exposure supported confidence but was not the sole driver of benefit perceptions. Associations with perceived barriers were relatively low across all constructs ($r = .14-.21$), implying that concerns about ethics, academic honesty, or infrastructure were relatively independent of teachers' levels of familiarity, readiness, and perceived benefits.

Responses from Open-Ended Questions

Teachers' qualitative comments provided richer insights that complemented the quantitative findings. Of the 147 survey participants, 32 provided substantive written responses to the optional open-ended question (a response rate of 21.7%). All 32 responses were included in the analysis. Thematic analysis of 32 substantive responses revealed four overarching themes:

Pedagogical Benefits for Student Learning

Teachers emphasized the practical value of the workshop, noting that the training offered clear guidelines for project design and could "reduce time spent reviewing problems and solutions." Several highlighted its relevance for project-based learning, suggesting that hands-on approaches would strengthen student learning outcomes.

Professional Growth and Teacher Readiness

Many respondents described the training as an opportunity for skill development and confidence-building. Comments reflected both immediate learning, such as "I learned a lot," and aspirations for further exploration, including the desire to "go deeper into Canva AI and apply the code in practice." Teachers expressed motivation to continue engaging with GenAI tools as part of their professional growth.

Barriers and Concerns

The most frequently cited barrier was the limited duration of the training. Participants noted that the session was "too short," covered "too much content for the available time," and offered "little chance to exchange ideas." These concerns highlight the need for extended sessions that allow deeper engagement and collaborative discussion.

Recommendations for Implementation

Teachers offered constructive suggestions to enhance future training. Key recommendations included extending workshop duration, offering onsite delivery, and providing additional hands-on practice. Respondents also requested subject-specific examples, follow-up sessions, teacher manuals, and clearer guidance on assessment practices when using AI. Peer sharing of experiences was also emphasized as a valuable resource for implementation.

In summary, the qualitative findings reinforced the survey results by illustrating both enthusiasm for the pedagogical potential of GenAI and the recognition that sustained, structured professional support will be essential for effective integration.

Discussion

Teachers in this study reported high readiness to experiment with GenAI and identified clear pedagogical benefits for Design & Technology (D&T), particularly in creativity support, idea generation, and scaffolding project-based learning. Interpreted through the TPACK lens, these patterns suggest that teachers perceive GenAI as a technology that can be productively aligned with D&T content and pedagogy rather than as an add-on tool, a prerequisite for meaningful technology integration (Koehler & Mishra, 2009). This aligns with recent evidence that GenAI can augment instructional design and creative tasks in teacher preparation courses and authentic design projects, provided it is embedded in structured, praxis-oriented activities (Panday-Shukla, 2025). Broader syntheses of AI in education similarly highlight gains in customization, content creation, and workflow efficiency, benefits that likely translate into teachers' sense of efficacy and willingness to integrate GenAI in domain-specific tasks (Zhang & Aslan, 2021; Zawacki-Richter et al., 2019; Cotton et al., 2023).

While enthusiasm was high, teachers also surfaced systemic needs that condition sustainable use: clearer local policies and norms, opportunities to deepen ethical literacy, and sufficient time and resources to practice with D&T-relevant tasks. These findings mirror cross-national studies in which educators expressed willingness to adopt GenAI but emphasized constraints related to institutional guidance, cost/access, and prompting/assessment know-how (Zhang et al., 2024). Other research similarly documented positive readiness coupled with uncertainties around policy and ethics (Kasneci et al., 2023). At the field level, systematic reviews note a persistent imbalance between research on AI applications for teaching and research on teacher professional development (PD), calling for programs that explicitly build teachers' AI literacy and pedagogical capacity (Tan et al., 2025). Competency frameworks co-created with teachers similarly argue that effective and ethical GenAI use requires intentional development across knowledge, skills, values, and agency, not merely tool exposure.

Taken together, our results converge with emerging international evidence: teachers are motivated and perceive sizable pedagogical dividends from GenAI, yet require organizational and developmental supports to translate intent into durable practice (Kasneci et al., 2023; Tan et al., 2025; Zhang et al., 2024). This study advances the conversation by focusing specifically on D&T teachers and project-based pedagogy. By documenting readiness and perceived benefits in a design-oriented subject area, our findings complement practice-based accounts showing that GenAI integration is most productive when tied to concrete design artifacts, iterative feedback, and co-creation with learners (MacDowell et al., 2024; Panday-Shukla, 2025).

Findings argue for professional development that is iterative and practice-embedded, with cycles of design-implementation-reflection anchored in real Design and Technology projects; domain-specific, offering exemplars and templates for common Design and Technology workflows (e.g., ideation briefs, prototype critiques, rubric-aligned feedback); and literacy-building, integrating core concepts of how GenAI works, its limitations, and ethical use including bias, attribution, and data privacy (Tan et al., 2025). Co-designing professional development with teacher educators and participants can foster ownership and yield context-fit resources such as classroom task banks, prompting guides, and evaluation checklists (MacDowell et al., 2024). At the policy level, institutions should articulate transparent guidelines for acceptable use, assessment integrity, and data governance while ensuring equitable access to tools and infrastructure, conditions repeatedly flagged in the literature as enablers of responsible adoption (Cotton et al., 2023; Zawacki-Richter et al., 2019).

Limitations and directions for future research

This study relied on self-report data following a single, short-duration (three-hour) professional development course in Thailand. While this duration was sufficient to establish introductory familiarity, the focus of this study, it is acknowledged as a limitation for developing deep pedagogical mastery. Consequently, longitudinal and classroom-embedded designs are needed to track how readiness translates into instructional change and student outcomes. Future work should examine growth in TPACK with GenAI over time, compare professional development models (e.g., coaching vs. workshop series) for the design and technology integration, and evaluate impacts on student creativity, problem-solving, and design quality. Given calls to rebalance the evidence base toward teacher learning, studies that connect professional development design, policy context, and measured classroom practice will be especially valuable (Tan et al., 2025). Investigations that include both teacher educators and pre-service teachers can further illuminate diffusion dynamics and capacity-building needs across the educator pipeline (Panday-Shukla, 2025; MacDowell et al., 2024).

CONCLUSIONS

This study shows that Design and Technology (D&T) teachers are motivated and prepared to adopt Generative AI (GenAI), recognizing benefits for creativity, project-based learning, and student engagement. At the same time, participants expressed a strong preference for systemic supports, such as subject-specific exemplars, continued professional development, and clearer institutional policies, to facilitate meaningful integration. By focusing on Design and Technology, the study adds a subject-specific perspective often absent in AI in education research. Findings reinforce TPACK as a useful lens for explaining how GenAI can connect technology, pedagogy, and content. They also point to the importance of professional development that is iterative, domain-specific, and ethically grounded, supported by clear institutional guidelines. In sum, while teacher enthusiasm is evident, sustainable adoption will depend on systemic supports that translate readiness into enduring classroom practice.

DECLARATIONS

This research received no external funding. The authors declare no conflicts of interest. All procedures involving human participants followed institutional ethical standards and the Declaration of Helsinki, with voluntary participation and informed consent obtained. The dataset is available from the corresponding author upon reasonable request. The study was conceived, designed, and conducted by the authors, who also analyzed the data and prepared the manuscript. The authors gratefully acknowledge the participating teachers for their valuable contributions.

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