

Development of a Professional Coaching Model to Enhance Digital Technology Competency for Primary Teachers: A Mixed-Methods Study

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ABSTRACT

Background and Objectives: In 21st century education, digital technology integration in education is crucial, but primary teachers often struggle with it. Previous professional development efforts have not significantly transformed teachers' learning management practices. Instructional coaching, a promising approach, has shown encouraging behavioral outcomes but lacks empirical research on its effectiveness in authentic classroom contexts. In this study, we aimed to develop and evaluate a new model—the Digital Integration through Coaching and Technological Pedagogical Content Knowledge (TPACK) Framework (DICT model)—designed to enhance primary teachers' competency in integrating digital technology through TPACK.

Methodology: The study employed a mixed-methods design, with the sample group consisting of 64 primary school teachers from 12 schools in two zones of the Bangkok Education Office, specifically focusing on fourth-grade teachers. The development of the DICT model guided the ADDIE model approach. Data collection tools included a form to observe and assess teachers' skills in using educational technology based on the TPACK framework, along with semi-structured interviews to understand the views and experiences of both coaches and primary teachers using the model. The data analysis of quantitative data included t-tests and ANOVA. We analyzed qualitative data from reflections and interviews using thematic analysis.

Main Results: The DICT model significantly improved teachers' TPACK competencies and confidence in integrating digital technology. The developed DICT model consisted of five core components (coach team, coachee, TPACK-based framework, digital toolkits, and reflective & follow-up system) and five activity steps: (1) provision of knowledge, (2) collaborative planning, (3) observation, (4) reflection, and (5) follow-up. The DICT model significantly improved teachers' knowledge, skills, and behavior

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when teachers integrated digital technology into learning activities. The mean score for learning management behavior using digital technology increased significantly in the second coaching session when compared to the first coaching session ($p < .05$). Level 1 teachers revealed a higher integration of digital technology in their teaching compared to pre-teachers and Level 2 teachers. Thematic analysis of interviews and reflections revealed increased teacher confidence, positive attitudes towards technology, and heightened awareness of technology's function.

Discussion: The DICT model is an instructional coaching approach that focuses on continuous observation, reflection, and monitoring of teacher action and outcomes. It incorporates group training and personalized feedback, aiming to bridge gaps in technology integration across different subject areas. The model's four-month implementation period allows teachers to adjust to new technologies. The coaching process enhances teachers' confidence in selecting and implementing digital technologies, increasing self-efficacy. It also improves primary teachers' ability to integrate TPACK in practice, transforming technology from an external toolkit to an essential part of instructional design.

Conclusions: The DICT model is a sustainable professional development approach for primary teachers to enhance their digital technology competency. It involves continuous observation, reflection, and monitoring, offering group training and personalized feedback. The model enhances primary teachers' digital integration competency in their classroom activities through coaching and the TPACK framework, while fostering positive attitudes and a better understanding of technology's role in learning design.

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Introduction

The 21st century classroom has been driven by transformations in teaching methods, the role of teachers, and the use of technology to enhance learning. There is a growing worldwide trend to position digital technology as the main focus of development in many areas of education, which now includes using generative artificial intelligence (AI) tools (Ruiz-Rojas et al., 2023). Moreover, teacher

coaching has emerged as a promising alternative to traditional models (Kraft et al., 2018). Consequently, teachers need to cultivate competency in digital education technology alongside skills in learner-centered management to provide learners with essential skills, including analytical thinking, problem solving, lifelong learning, and critical technology utilization (Haleem et al., 2022).

Backfisch et al. (2021) found that teachers from different subjects showed very different abilities in using digital education technology in their lessons, particularly in understanding and choosing the right tools and creating effective tech-based learning activities. These differences were especially pronounced in primary schools that had limited resources, time, and chances for ongoing professional development. In the past, teacher development regarding digital education technology was often delivered through traditional lecture-based approaches. While these methods may enhance knowledge to a degree, they fail to substantially transform teachers' learning management practices. This observation aligns with the conclusions of Desimone and Pak (2017), who contended that lecture-based professional development rarely results in significant changes to instructional practices, despite increasing content knowledge. Similarly, Knight (2007) emphasized the need for coaching to support real behavioral transformation in teachers. Additionally, this matches the findings of Ruggiero and Mong (2015), which indicated that the absence of reflective thinking and practical classroom applications makes it difficult to truly use technology in K-12 education.

An analysis of effective teacher development methodologies identified *instructional coaching* as a strategy that yields distinct behavioral outcomes, and coaching has a more sustainable effect than general training (Desimone & Pak, 2017). This is particularly true when it incorporates direct classroom observation, personalized feedback, and continuous monitoring to motivate teachers and afford them opportunities to refine their teaching methods and appropriately integrate technology within their contexts (Gibbons & Cobb, 2017; Knight, 2007; Kraft et al., 2018). Despite the growing interest in instructional coaching, there is a dearth of research on the effectiveness of coaching programs in assisting K-12 teachers in utilizing technology, particularly in primary classroom settings. Furthermore, there is limited research assessing the efficacy of teachers' digital literacy advancement through actual school-based coaching models (Liao et al., 2021).

A systematic review conducted by Rodríguez Moreno et al. (2019) revealed that training incorporating Information and Communication Technology (ICT) within Technological Pedagogical Content Knowledge (TPACK) framework was most utilized by primary school teachers (35.3%). Additionally, the integration of TPACK with ICT yielded a positive outcome in 51% of cases. The review by Wang et al. (2018) recommended that teacher training should provide support and examples to show how to use TPACK, that research should use different methods for a complete understanding, and that new or improved tools should be developed to properly assess TPACK integration, with a focus on performance evaluation, observation, and reflection. Furthermore, the cultivation of TPACK should be a continuous endeavor rather than a short training session (Brinkley-Etzkorn, 2018).

This study acknowledged the necessity of creating a professional development coaching model aimed at enhancing primary teachers' digital integration competency through coaching and the TPACK framework. The model was designed by the research team and instructional design experts capable of integrating knowledge with practical application and systematically developing

teachers' digital integration competency, and it serves as a crucial mechanism for enhancing the quality of Thai education in alignment with the digital era.

Review of Literature

This study is grounded in the theory of experience created by John Dewey in 1938 (Miettinen, 2000), the instructional coaching model (Knight, 2007), and the TPACK Framework (Mishra & Koehler, 2006).

Theory of Experience

John Dewey's theory of experience provides a foundational account of learning, emphasizing that knowledge and skills are cultivated via engagement with the environment and subsequent reflection on those experiences. This theory comprises two main principles: continuity and interaction. The principle of continuity posits that prior experiences influence future learning, establishing a nexus among past, present, and future educational endeavors. The principle of interaction emphasizes that significant learning transpires through active engagement between individuals and their environments (Miettinen, 2000).

In educational contexts, these principles indicate that effective professional growth should occur in genuine environments where learners can integrate new information with previous experiences (Miettinen, 2000). Coaching-based professional development reflects Dewey's principles by providing ongoing, contextual support that enables teachers to learn through practice and reflection (Gibbons & Cobb, 2017; Knight, 2007). In alignment with Zimmer and Matthews (2022), professional development should emphasize content application, retention, relevance, reflection, and follow-up to assess impact.

Instructional Coaching Model

The instructional coaching approach is a method in which specialists (coaches) interact with teachers to enhance instructional practice through observation, offering recommendations, and facilitating systematic reflection. Coaches are not teachers but rather professional partners who collaboratively think, plan, and assess instruction with teachers (Knight, 2007). The originator of the instructional coaching concept, identified seven core factors: (1) partnership, in which coaches collaborate with teachers as professional colleagues; (2) dialog, which emphasizes in-depth discussions rather than simple directives; and (3) modeling, whereby coaches demonstrate techniques or teaching methods. Instructional coaching also involves (4) observation, in order to monitor the implementation of learning management; (5) constructive feedback offered by the coaches, and (6) reflection, whereby teachers are encouraged to examine their own instruction. Finally, (7) goal setting involves collaboratively establishing explicit developmental objectives.

Consequently, instructional coaching assists teachers in embracing innovative technology in the classroom, obtaining individualized and specific feedback, enhancing their knowledge and abilities in TPACK, and achieving measurable modifications in teaching practices. This approach is consistent with the conclusions of Gibbons and Cobb (2017), who found that coaching incorporating observation and continual feedback influenced teachers' utilization of technology. Moreover, a

meta-analysis by Kraft et al. (2018) revealed that instructional coaching positively influenced student achievement.

For example, first, a coach observes a lesson and identifies the teacher's apprehension toward using digital media. Second, the coach then demonstrates the use of the straightforward educational technology. Third, the teacher implements this technology in a lesson plan that aligns with the topic content and teaching strategies (content focus). Fourth, the coaches offer feedback to enhance the teacher's proficiency in educational technology, fostering active learning (active learning). Finally, the teacher subsequently reflects on and revises the lesson plan, ensuring sustained improvement (sustained duration). Coaches also facilitate collaborative learning among teachers, aligning their development with pertinent standards, curricula, and policies (collective participation and coherence) (Desimone & Pak, 2017). In coaching, activities must incorporate high-quality professional development characteristics, including intensity and continuity, relevance to teachers' actual instructional challenges, emphasis on student cognition, community-based learning among teachers, active learning (Gibbons & Cobb, 2017), and personalized feedback (Zimmer & Matthews, 2022).

Consequently, instructional coaching is an effective teacher development approach, particularly in augmenting the integration of technology inside the classroom, as it is grounded in teachers' actual circumstances, allowing them to experiment, implement, and reflect on outcomes with experts.

Instructional Coaching Model

TPACK was developed by Mishra and Koehler (2006) and Koehler et al. (2013) (Figure 1), by extending the concept of Shulman (1986) on pedagogical content knowledge (PCK). The principal of TPACK in teacher development is that the framework helps teachers not only understand the technology but also recognize the appropriate contexts and methodologies for its application. This framework for analyzing teachers' behavior and potential in learning management encourages teachers to integrate technology meaningfully, not just not simply using it just for the sake of using it (Chai et al., 2013; Nithitakkharanon & Nuangchalem, 2022). Furthermore, TPACK is a theoretical framework with significant potential for the design of integrated ICT for teacher training (Rodríguez Moreno et al., 2019).

Using TPACK in teacher development, for example, involves evaluating teachers' TPACK before and after coaching (Brinkley-Etzkorn, 2018; Motto, 2021), establishing guidelines for designing coaching content to enhance specific knowledge (Jang, 2010), and developing and testing an empirical models based on TPACK concepts (Chai et al., 2019). For instance, if a teacher utilizes Canva to arrange worksheets in the classroom, this exemplifies the application of technological knowledge (TK). However, if a teacher uses Canva to design group activities aligned with subject content and project-based learning (PBL), this exemplifies TPACK. Therefore, TPACK serves as a crucial conceptual framework that explains how teachers can effectively integrate digital technology into their teaching and learning by emphasizing the appropriate combination of technology, teaching methods, and subject content.

Figure 1

TPACK Framework (Koehler et al., 2013)

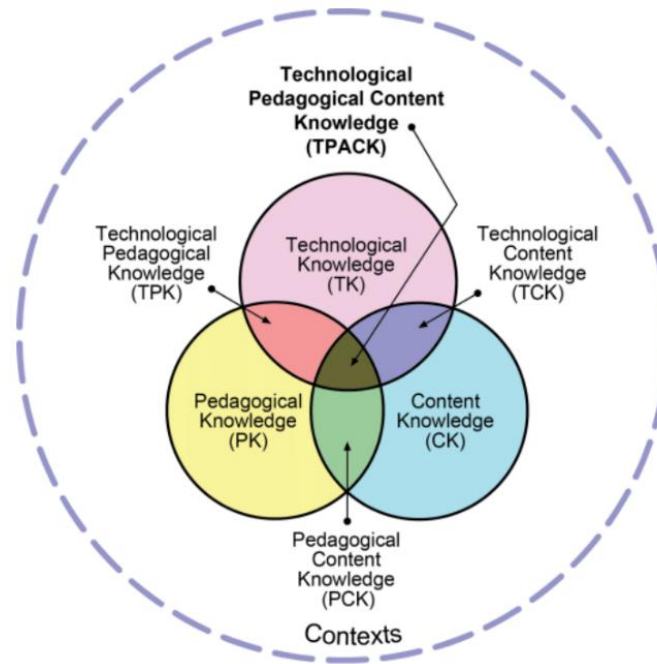
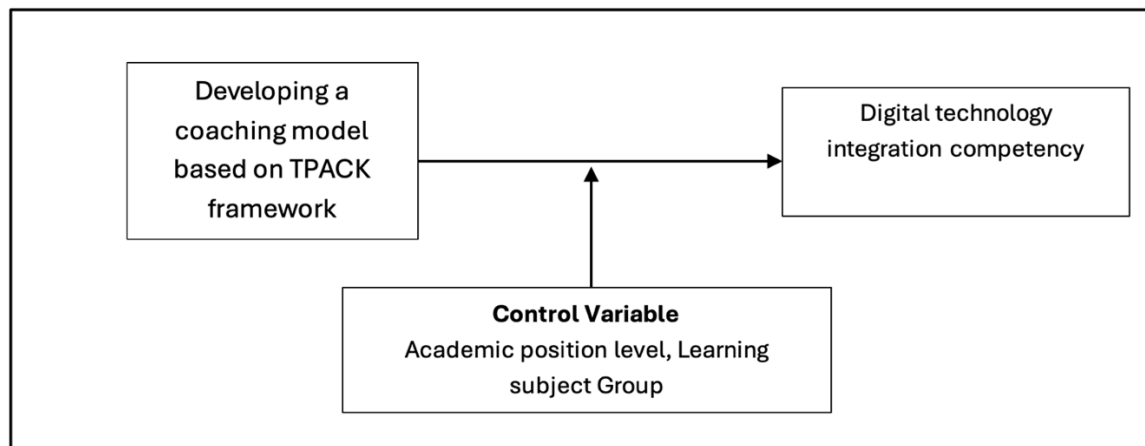


Figure 2

Research Framework



Method

Figure 2 illustrates the scope of the study, which employs a mixed-methods strategy that integrates qualitative and quantitative techniques. The sample comprised 64 fourth-grade teachers in primary school from 12 schools in two zones (Lat Krabang and Min Buri) of the Bangkok Education Office. The selection of volunteers for this study was conducted through the dissemination of posters to each school in both zones. Sixty-four volunteers were recruited. The research tools used were as follows: (1) a form to observe teaching behaviors based on the TPACK framework (which is

a way to integrate digital learning), and (2) a form for interviews to understand how coaches and primary teachers feel about their experiences using the model. This study was approved by the Ethics Committee of the Human Ethics Review Committee, Chulalongkorn University, approval code 670470. All participants gave their informed consent before participating. The study ensured the confidentiality and anonymity of all data collected.

Data analysis involved descriptive statistics (means and standard deviations), paired-sample t tests, one-way ANOVA, and thematic analysis. We conducted an experiment to create a model that aligned with the ADDIE model principles established by Branch and Varank (2009).

Procedures

Step 1: Analyze

We conducted a study of the current circumstances and requirements of primary school teachers regarding the integration of digital technology in learning activities and reviewed relevant preliminary literature as well as the educational policies of the Bangkok Metropolitan Administration Educational Service Area Office. The research questions, data sources, and data analysis methods used are shown in Table 1.

Table 1

Research Questions, Data, and Analysis

Research Questions	Data Source	Analysis
1. What are the components and steps of the DICT model to increase primary teachers' digital education technology competency?	- Instruction design professional evaluation	- The index of item-objective congruence (IOC) and instruction design professionals' recommendation
2. To what extent can the DICT model increase primary teachers' digital education technology competency?	- 1 st time – 2 nd time scores from an observation form for evaluating teachers' competency, focusing on integrated educational technology based on the TPACK framework by coaches.	- T-test (paired-sample t-test)
3. After coaching, do teachers in different academic positions show significantly different levels of digital education technology competency?	Post-test scores from an observation form used to evaluate teachers' competency are analyzed for groups of teachers with	ANOVA, post hoc

Table 1

(Cont.)

Research Questions	Data Source	Analysis
	different academic positions.	
4. After coaching, do teachers from different subject groups demonstrate significantly different levels of competency in digital education technology?	Post-test scores from an observation form are used to evaluate teachers' competency across different subject groups.	ANOVA, post hoc
5. How do coaches and coachees perceive the effectiveness of the DICT model for primary teachers integrating digital educational technology in learning activities?	- Focus group data and personal interview data.	Thematic analysis

Step 2: Design

We created the DICT model (Primary Teachers' Digital Integration through Coaching and TPACK Framework) shown in Figure 3, and developed a form to observe teaching behaviors based on the TPACK framework (the digital learning integration matrix). This framework included seven parts (TK, PK, CK, and the combined parts TPK, TCK, PCK, and TPACK), with a Cronbach's Alpha of ≥ 0.81 , and identified the indicators as detailed in Table 2.

Table 2

The Assessment Form for Primary Teachers' Competency in Integrating Digital Technology in Teaching and Learning According to the TPACK Framework, Including Examples of Indicators

TPACK framework	Sample of items
TK	Teacher can select digital tools that are suitable for their learning activities.
PK	Teacher can plan active learning or teaching strategies in each subject group.
CK	Teacher has a deep understanding of the subject content they teach.
TCK	Teacher selects digital educational technology that appropriately supports the subject content being taught.
TPK	Teacher knows techniques or strategies for structuring technology-enhanced learning activities that facilitate student engagement.
PCK	Teacher can explain difficult content in a way that is appropriate for the learners' age. Design questions that stimulate critical thinking in lessons.
TPACK	Teacher can design learning plans that integrate content, teaching methods, assessments, and learning technologies.

Note: T (Technological Knowledge), P (Pedagogical Knowledge), C (Content Knowledge)

Step 3: Develop

The model was validated by five learning design experts. We then made revisions based on their feedback to enhance clarity and feasibility, ultimately deeming the model testable in teaching activity situation scenarios, $IOC \geq 0.80$.

Step 4: Test

We tested the developed model as shown in Figure 3 and the learning activity details in Table 3, with 64 fourth-grade primary school teachers across 12 schools during the period of November 2024 to March 2025.

Step 5: Evaluate

We evaluated the model's quality using the multiple sources of data. First, a paired sample t-test was used to evaluate teachers' competency development across two coaching cycles. Next, two rounds of coding were conducted for thematic analysis using all gathered data (Nowell et al., 2017). After identifying themes, the analysis performed involved interpreting these themes and correlating the interpretations with the research questions. The coding process showed themes based on the categories from group and individual interviews, such as changes in behavior, views and attitudes, experiences with coaching, factors that help technology integration, future growth of TPACK, and the challenges faced.

Findings and Discussion

This study examined the development of a professional development coaching model to enhance primary teachers' digital education technology competency and their experiences, recognizing and developing their digital learning technology skills integrated into instructional designs or lesson plans as follows:

The DICT Model (Research Question 1)***Details of the Developed Coaching Model***

1.1 Model Designation: DICT-Model (Digital Integration through Coaching and TPACK Framework).

The Model Consists of Five Core Components. Component 1 is the coach team, comprising experts in instructional educational technology. Component 2 is the coachee, referring to primary school teachers receiving coaching. Component 3 is applying the TPACK framework TPACK framework, to set behavioral goals for learning management using digital educational technology. Component 4 is the digital Toolkit, included digital educational technology tools (toolkit), artificial intelligence for education (AI), digital instructional designs, recommended teaching strategies, and learning communities. And component 5 is the reflective and follow-up system; Involved post-classroom observation and an evaluation form to assess teachers' competency with integrated educational technologies or digital education toolkit in learning activity.

Table 3

Roles of the Five Steps of Activity Forms in the DICT Model

Coaching Step	Coach Role	Coachee Role
Step 1: Provision of knowledge	On-site, the coaching team offers knowledge and practical experience regarding digital educational technology tools and artificial intelligence for digital classrooms, which include digital classroom setup, online media, rubric development, evaluation, and assignments. To facilitate the adoption of AI in educational settings, teachers can implement learning experiences that students to AI platforms. For instance, instructing students on easy search and interaction. However, such instruction must be balanced with an emphasis on the ethical implications and potential biases associated with AI-generated content. Online, the coaching team offers and demonstrates the recommended digital educational technology tools in the digital education technology community.	The teacher participates in both on-site and online sessions to digital educational technology tools and artificial intelligence within a designated timeframe, and the learning can be repeated.
Step 2: Collaborative planning	The coaching team and teacher collaborate to create instructional designs that incorporat digital educational technology and teaching strategies, setting leaning objectives.	The coaching team and teacher collaboratively establishes individual objectives prior to actual instruction, formulating a lesson plan that incorporates digital technology and teaching strategies. The teacher develops five topics in the digital classroom for self-teaching and receive online consultation with a coach

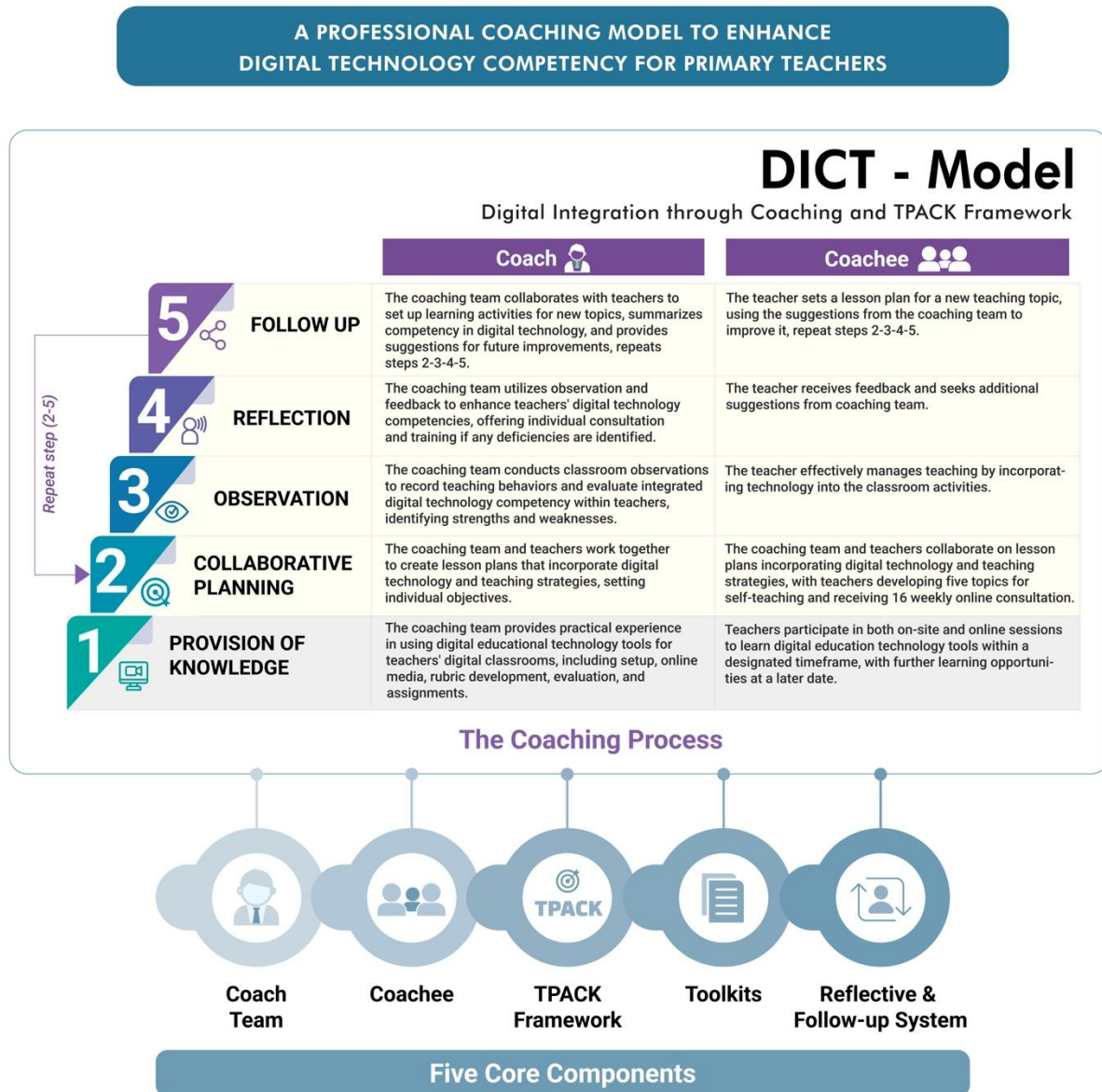
Table 3

(Cont.)

Coaching Step	Coach Role	Coachee Role
		team. The coaching team offers 16 weekly online consultations. The coaching team assesses teachers' competence, focusing on integrating digital educational technology tools into instructional designs. Each assessment occurs one month apart.
Step 3: Observation	The coaching team conducts classroom observations to record teaching behaviors and evaluate integrated digital educational technology competency within teachers, identifying strengths and weaknesses.	The teacher effectively manages teaching by incorporating digital educational technology tools into the classroom.
Step 4: Reflection	The coaching team utilizes observation and feedback to enhance teachers' digital educational technology competency, offering individual consultation and training if any deficiencies are identified.	The teacher receives feedback and seeks additional suggestions from coaching team.
Step 5: Follow up	The coaching team conducts follow-ups and revisits from observation and reflection activities to collaborate with the teacher in setting up learning activities for a new topic. Finally, the coaching team summarized the competency in integrated digital educational technology within teacher's learning activity design of each teacher and provided suggestions for future improvements. (Repeating steps 2-3-4-5) to collaborate setting an instructional design or a new lesson plan with coachee	The teacher sets a lesson plan for a new teaching topic, using the suggestions from the coaching team to improve it. (Repeat steps 2-3-4-5) to collaborate setting a new instructional designs or lesson plan with a coaching team.

Figure 3

The DICT Model (Digital Integration Through Coaching and TPACK Framework)



The DICT Model (Research Question 2)

Results of the DICT-Coach Model Test

Table 4

The Demographics of the Sample Group in the Experiment Using the DICT Model

Categories	Count (n)	Percentage (%)
Sex		
Male	21	32.81
Female	43	67.19

Table 4
(Cont.)

Categories	Count (n)	Percentage (%)
Academic position		
Pre-teacher	21	32.81
Teacher (Level 1)	16	25.00
Expert Teacher (Level 2)	18	28.13
Special Expert Teacher (Level 3)	9	14.16
Learning subject group		
Science and Technology (Computer)	8	12.50
Science and Technology	12	18.75
Foreign language	9	14.16
Mathematics	7	10.94
Vocational work	3	4.69
Music and dance	3	4.69
Social studies, religion, and culture	8	12.50
Health education and physical education	4	6.25
Thai language	7	10.94
Art	3	4.69

The DICT Model Test (Research Question 2)**Results of the DICT Model Test****Table 5**

Comparison of the Disparities in Evaluation Scores Regarding Primary School Teachers' Competency in Integrating Digital Educational Technology in Learning Activity (n =64)

Learning management behavior	$\bar{x}$	SD	t
Time 1	2.22	.39	-13.81*
Time 2	2.58	.28	

Note: * $\alpha = .001$

Table 5 shows the results of the comparative analysis of primary school teachers' learning management behavior scores using digital educational technology and indicates that the mean score of the second coaching session ($\bar{x} = 2.58$, $SD = 0.28$) was higher than the average of the first coaching session ($\bar{x} = 2.22$, $SD = 0.39$). The paired-sample t-test analysis revealed a statistically significant difference at the .05 level, $t(63) = 13.81$, $p < .05$.

Results of Multiple Comparison

Table 6

Results of the Analysis of the Differences in Scores After the Second Coaching Session Among Sample Groups with Different Academic Positions in ANOVA Analysis

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.743	3	.248	3.517	
Within Groups	4.227	60	.070		.020
Total	4.970	63			

First, the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that all academic positions followed a normal distribution and were suitable for variance analysis. Consequently, Table 6 reveals that the findings of the analysis of variance indicate the significance level. The value was .020, which was below the significance level of $\alpha = .05$. Therefore, it can be inferred that at least one pair of means was significantly different at the .05 level.

Different Academic Positions (Research Question 3)

Results of Different Academic Positions

Table 7

Results of Multiple Comparisons (Post Hoc Tests) on the Scores Following the Second Coaching Session Among Sample Groups with Different Academic Positions (n=4)

Multiple Comparisons							
	(I) Position	(J) Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	pre level	1 level	-.246	.088	<.001	-.48	-.01
		2 level	.019	.085	1.0	-.21	.24
		3 level	-.082	.106	.9	-.36	.20
	1 level	pre level	.246	.088	<.001	.01	.48
		2 level	.265	.091	<.001	.02	.51
		3 level	.164	.111	.5	-.13	.46
	2 level	pre level	-.019	.085	1.0	-.24	.21
		1 level	-.265	.091	<.001	-.51	-.02
		3 level	-.101	.108	.8	-.39	.19
	3 level	pre level	.082	.106	.9	-.20	.36
		1 level	-.164	.111	.5	-.46	.13
		2 level	.101	.108	.8	-.19	.39
Scheffe	pre level	1 level	-.246	.088	.1	-.50	.01
		2 level	.019	.085	1.0	-.23	.26
		3 level	-.082	.106	.9	-.39	.22

Table 7
(Cont.)

Multiple Comparisons						
(I) Position	(J) Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 level	pre level	.246	.088	.1	-.01	.50
	2 level	.265	.091	<.001	.00	.53
	3 level	.164	.111	.5	-.15	.48
2 level	pre level	-.019	.085	1.0	-.26	.23
	1 level	-.265	.091	<.001	-.53	.00
	3 level	-.101	.108	.8	-.41	.21
3 level	pre level	.082	.106	.9	-.22	.39
	1 level	-.164	.111	.5	-.48	.15
	2 level	.101	.108	.8	-.21	.41

The results in Table 7 showed that using the Tukey and Scheffe methods, level 1 academic status resulted in primary school teachers using digital technology in teaching management more than pre-teachers and level 2 teachers. However, level 3 did not show a significant difference in how well they integrated digital educational technology in teaching management ($\alpha=.05$). However, Level 3 exhibited no significant difference in the achievement of integrating digital technology in teaching management ($\alpha=.05$).

Different Subject Groups (Research Question 4)

Results of Different Subject Groups

Table 8

The Results of the Analysis of the Differences Following the Second Coaching Session Among the Sample Groups with Different Subject Groups (n = 10)

ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.39	9	.16	2.34	.026
Within Groups	3.58	54	.07		
Total	4.97	63			

First, the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that all learning groups exhibited normal distributions. Next, they were selected to analyze variance using the Scheffe and Tukey methods, assuming equal variances. Therefore, Table 8 reveals that the analysis of variance results indicated the significance. The value was .026, which was less than $\alpha=.05$. Consequently, it can be inferred that there was at least one pair of means that was statistically significantly different at the .05 level. (see detail in Table 9)

Table 9

The Results of the Multiple Comparison Analysis of the Scores Following the Second Coaching Session Among the Sample Groups with Different Learning Subject Groups (n = 10)

Multiple Comparisons							
	(I) Categetory	(J) Categetory	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Computer	Science	.203	.117	1	-.18	.59
		English	.193	.125	1	-.22	.61
		Math	.065	.133	1	-.37	.50
		Occupation	.214	.174	1	-.36	.79
		music	.297	.174	1	-.28	.87
		Social	.344	.129	<.001	-.08	.77
		Health	.594	.158	<.001	.07	1.11
		Thai	.313	.133	<.001	-.13	.75
		Art	.068	.174	1	-.51	.64
	Science	Computer	-.203	.117	1	-.59	.18
		English	-.010	.113	1	-.38	.36
		Math	-.138	.122	1	-.54	.27
		Occupation	.010	.166	1	-.54	.56
		Music	.094	.166	1	-.45	.64
		Social	.141	.117	1	-.25	.53
		Health	.391	.149	<.001	-.10	.88
		Thai	.110	.122	1	-.29	.51
		Art	-.135	.166	1	-.68	.41
	English	Computer	-.193	.125	1	-.61	.22
		Science	.010	.113	1	-.36	.38
		Math	-.128	.130	1	-.56	.30
		Occupation	.021	.172	1	-.55	.59
		Music	.104	.172	1	-.46	.67
		Social	.151	.125	1	-.26	.56
		Health	.401	.155	<.001	-.11	.91
		Thai	.120	.130	1	-.31	.55
		Art	-.125	.172	1	-.69	.44
	Math	Computer	-.065	.133	1	-.50	.37
		Science	.138	.122	1	-.27	.54
		English	.128	.130	1	-.30	.56
		Occupation	.149	.178	1	-.44	.73
		Music	.232	.178	1	-.35	.82

Table 9*(Cont.)*

Multiple Comparisons						
(I)	(J)	Mean	Std.	Sig.	95% Confidence	
Categetory	Categetory	Difference	Error		Interval	
		(I-J)			Lower	Upper
					Bound	Bound
Occupation	Social	.279	.133	1	-.16	.72
	Health	.529	.161	<.001	.00	1.06
	Thai	.248	.138	1	-.21	.70
	Art	.003	.178	1	-.58	.59
	Computer	-.214	.174	1	-.79	.36
	Science	-.010	.166	1	-.56	.54
	English	-.021	.172	1	-.59	.55
	Math	-.149	.178	1	-.73	.44
	Music	.083	.210	1	-.61	.78
	Social	.130	.174	1	-.44	.71
	Health	.380	.197	1	-.27	1.03
	Thai	.099	.178	1	-.49	.69
	Art	-.146	.210	1	-.84	.55
	Computer	-.297	.174	1	-.87	.28
	Science	-.094	.166	1	-.64	.45
	English	-.104	.172	1	-.67	.46
	Math	-.232	.178	1	-.82	.35
	Occupation	-.083	.210	1	-.78	.61
	Social	.047	.174	1	-.53	.62
Music	Health	.297	.197	1	-.35	.95
	Thai	.016	.178	1	-.57	.60
	Art	-.229	.210	1	-.92	.46
	Computer	-.344	.129	<.001	-.77	.08
	Science	-.141	.117	1	-.53	.25
	English	-.151	.125	1	-.56	.26
	Math	-.279	.133	1	-.72	.16
	Occupation	-.130	.174	1	-.71	.44
	Music	-.047	.174	1	-.62	.53
Social	Health	.250	.158	1	-.27	.77
	Thai	-.031	.133	1	-.47	.41
	Art	-.276	.174	1	-.85	.30
	Computer	-.594	.158	<.001	-1.11	-.07
	Science	-.391	.149	<.001	-.88	.10
	English	-.401	.155	<.001	-.91	.11
	Math	-.529	.161	<.001	-1.06	.00
	Occupation					
	Music					
Health	Computer					
	Science					
	English					
	Math					

Table 9*(Cont.)*

		Multiple Comparisons				
(I) Categetory	(J) Categetory	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Thai	Occupation	-.380	.197	1	-1.03	.27
	Music	-.297	.197	1	-.95	.35
	Social	-.250	.158	1	-.77	.27
	Thai	-.281	.161	1	-.81	.25
	Art	-.526	.197	<.001	-1.17	.12
	Computer	-.313	.133	<.001	-.75	.13
	Science	-.110	.122	1	-.51	.29
	English	-.120	.130	1	-.55	.31
	Math	-.248	.138	1	-.70	.21
	Occupation	-.099	.178	1	-.69	.49
Art	Music	-.016	.178	1	-.60	.57
	Social	.031	.133	1	-.41	.47
	Health	.281	.161	1	-.25	.81
	Art	-.245	.178	1	-.83	.34
	Computer	-.068	.174	1	-.64	.51
	Science	.135	.166	1	-.41	.68
	English	.125	.172	1	-.44	.69
	Math	-.003	.178	1	-.59	.58
	Occupation	.146	.210	1	-.55	.84
	Music	.229	.210	1	-.46	.92
	Social	.276	.174	1	-.30	.85
	Health	.526	.197	<.001	-.12	1.17
	Thai	.245	.178	1	-.34	.83

Table 9 presents the results of the pairwise comparison of means using the Tukey methods, indicating that the subject groups had significantly different means at the .05 level.

Coaches and Coachees Perceptions (Research Question 5)

Interviews and Reflections of Teachers and Coaches

The qualitative data analysis through thematic analysis of interviews and reflections from teachers and coaches revealed significant concerns, as presented in Table 10.

Table 10*Key Findings from Interviews and Reflections of Teachers and Coaches*

Theme	Sub-issues	Example Quotation
Teacher Perspective (Coachee)		
<i>Teacher Behavior Change</i>		
Increased teacher confidence in using digital education technology.	Teachers dare to experiment with new education technologies.	“At first, I had no experience with Quizizz or artificial intelligence platform for education. After my coach introduced me to it, I began using it in my instructional designs and using this educational tool in accordance with my teaching strategies.” “I feel more confident. I recognize the advantages of technology in organizing learning activities. In the future, I will be able to organize learning activities more efficiently.”
<i>Perception and Attitude</i>		
Positive attitudes towards technology.	Coaches facilitate the integration of educational technology with teaching techniques.	“The coach assists in lesson planning, uses educational technology consistent with teaching practices, and offers constructive feedback without assigning blame for errors or deficiencies in technological proficiency.”
<i>Experience with Coaching Process</i>		
Assessment and feedback of actual teaching scenarios, offering guidance and help with follow-up.	Teachers appreciate receiving individualized input.	“The coach offered comments during the first private observation of the teaching, significantly enhancing my confidence in using digital educational technology to facilitate learning activities in the second session.”
<i>Successful Integration Factors</i>		
Time for preparing for teaching.	This project is time-consuming, and there is no rush.	“Coaches offer guidance both online and through direct observation of teaching in practical contexts. The first and second sessions are significantly spaced, providing ample opportunity to acquire knowledge and develop digital classroom.”

Table 10

(Cont.)

Theme	Sub-issues	Example Quotation
Support from the School Director	The school director should know that we are enhancing our understanding of integrating digital educational technology into learning activities.	“The administrators arrived to observe the teaching, while the coaches came to observe the actual teaching.”
<i>TPACK Development through Coaching</i>		
TPACK Development through Coaching	Technological Knowledge (TK)	“Previously, I didn’t dare to allow students to submit homework or assignments for evaluation using a rubric in the digital classroom system due to my perception of its complexity. However, the coach provided a teaching step, which encouraged me to attempt it, and I now use it for daily routine worksheets.
	Technological Pedagogical Knowledge (TPK)	“The coach suggested that Kahoot should be used not only for quizzes but also to engage students and foster fun from the beginning of the lesson.”
	Technological Content Knowledge (TCK)	“On the topic of national performing arts, the coach facilitated the introduction of VR museum clips that demonstrate experiments that we can’t do in the lab, thereby enhancing the children’s understanding.”
	TPACK	“The coach assisted me in developing a course that integrated technology, teaching strategy, and material, resulting in a more seamless and engaging classroom experience.
<i>Limitations and Challenges</i>		
School support	Lack of sufficient computer room	“The school only has one computer room, so we have to allocate time for students’ usage.”

Table 10

(Cont.)

Theme	Sub-issues	Example Quotation
<i>Coach Perspectives</i>		
The implementation of digital technology in education	Teachers have enhanced their utilization of digital technology from fair, good, excellent.	“We should practice using digital classroom more fluently and increase the utilization of collaborative learning technologies such as Kahoot and Quizizz.” “Frequently used educational technology tools include VDO, Google Classroom, Google Docs, Kahoot, Canva, Word Wall, Gemini, and new media (e.g., Zep Quiz, Visual World).” “Teachers also need to develop a wider range of digital tools and ensure they're relevant to students.”
Development of teaching and educational activities	Development of educational activities	“The activities must be designed to be appropriate for the learners’ level, and the content should be organized in a timely manner.” “Some activities are still too complex for the learners. They must be modified to align with the temporal context and educational level.”
Classroom management and student engagement	Using a combination of online and traditional mixed media, such as flashcards and vocabulary cards, maintains students’ engagement.	“The activities integrate digital media with traditional handcrafted materials used by teachers, enhancing engagement and mitigating student boredom.”
Using rubrics and assessments	Using digital tools for assessment	“The organizing of learning activities should include assessment. Using online tests, such as Google Forms, or engaging in games to evaluate knowledge is feasible. First, I did not comprehend the proper use of rubrics. Following the guidance received following the first coaching session, I began to understand more. However, I was still not very fluent.”

Table 10*(Cont.)*

Theme	Sub-issues	Example Quotation
Suggestions and development guidelines	Simplifying the use of technology and providing guidelines that students can easily understand.	“When teaching fourth-grade students, technology should be selected that is not complicated, and it is not necessary to use technology more frequently than necessary.”

Table 10 presents qualitative findings derived from interviews, reflections, and teacher feedback regarding the coaching process. The analysis revealed several key themes. First, enhanced teacher confidence emerged, as teachers reported that coaching facilitated their confidence in using technology in learning management, particularly in the selection of suitable media and digital tools for the learning of both content and learners, although some teachers may require additional time. Enhanced TPACK-integrated instructional design: Following the first session, teachers demonstrated improved capability in planning and designing lessons that effectively integrated technology into content and teaching methods better after the first session (first training experience). Examples of this included using presentation programs, developing learner-centered activities, and using online assessment tools. Reflection and learning with coaches were significant motivators. Teachers emphasized that receiving in-depth feedback and analyzing lessons with coaches helped them to identify their strengths, limitations, and ways to improve their teaching practices. Finally, there is heightened awareness of the function of technology in the classroom and teachers perceive technology not just as a tool but as an integral component of learning design to enhance learners' competency in the 21st century.

Discussion

The findings highlight the importance of embedded professional learning structures in facilitating educational transformation. Moreover, the findings suggest that the DICT model is an effective professional development coaching model that enhances primary teachers' digital education technology competency. It emphasizes continuous observation, reflection, and monitoring focused on teacher actions and outcomes, including group training and personalized feedback. This aligns with recent findings by Wilder and Diec (2025) that underscored the importance of collaboration, reflection, and sustained comprehensive development in successful instructional coaching. Findings also align with the research by Zimmer and Matthews (2022) and are further supported by the meta-analysis of Kraft et al. (2018), which showed that coaching that includes group training is more effective than just one-on-one coaching alone. In addition, relationship support and partnership building between coaches and coachees, based on reflection and personalized feedback, have been identified as contributing factors (Ottenbreit-Leftwich et al., 2020).

The model implementation step of this study required five months, which is considered a long-term project. Because each teacher has unique ways of using technology, their varying levels of technological experience may mean that some teachers require considerable time to absorb and understand adjustments (Tuten & Marks, 2012). Interestingly, teachers with significant rank/position, despite their slower adoption of technology, effectively integrated traditional educational tools with new media in their teaching, engaging student interest and encouraging participation in learning activities (Magallanes et al., 2024). Following this coaching, coaches demonstrated the use of technology in the classroom as a model for teachers who were more familiar with traditional teaching methods. This aligns with the study by Liao et al. (2021), which indicated that coaches found classroom demonstrations to be the most useful form of support, as it helps instructors visualize expected practices in real-world situations more clearly.

Regarding generational differences, Level 1 teachers integrated digital educational technology into their teaching more extensively than other groups. This may be attributed to their greater familiarity with technology, as many belonged to a generation that grew up using computers, making them more receptive to new technologies. For example, the teacher trained students to type prompts into an AI platform to find answers based on scenarios prepared by the teacher. Furthermore, the findings suggest that Level 3 teachers (senior/experienced teachers) required a more scaffolded approach provided through the cycle of Planning, Observation, and Reflection. During the Planning step, coaches more helped senior teachers align new digital tools with their extensive pedagogical experience, ensuring that technology did not replace but rather enhanced their established methods. The Observation step (modeling) served as critical visual evidence that reduced technological anxiety, allowing them to see practical integration in a real classroom context (Gibbons & Cobb, 2017). Furthermore, the Reflection step provided a safe, non-judgmental space for senior teachers to evaluate their progress and receive personalized feedback. This iterative process facilitated a scaffolded approach, where senior teachers could leverage their classroom management strengths while incrementally incorporating AI and digital resources into their practice, as supported by the work of Kraft et al. (2018), Ottenbreit-Leftwich et al. (2020), and Zimmer and Matthews (2022).

Regarding academic position, the findings align with the study by Inan and Lowther (2010), which indicated that teachers who were raised with digital technologies were generally more receptive to integrating technology into their teaching. We observed that younger or mid-career teachers, having grown up with digital technology, tended to adopt new technologies more easily. Similarly, Desimone and Pak (2017) emphasized that mid-career teachers were often more responsive to professional development programs, as they balanced foundational experience with openness to innovation.

On the other hand, the results for Level 3 teachers supported what Mishra and Koehler (2006) found, showing that experienced teachers often relied on their strong teaching knowledge and established methods, which could make it harder for them to use new technologies unless these were introduced through thoughtful and relevant professional development. The findings of Siyam et al. (2025) aligned with this. They showed that training for teachers on technology greatly affected how confident they felt about using technology and how they used it in their classrooms, with clear differences in content knowledge (CK), pedagogical knowledge (PK), and pedagogical content

knowledge (PCK) depending on their age. Furthermore, Kraft et al. (2018) highlighted that instructional coaching could address this gap and allow seasoned teachers to effectively integrate technology while preserving their established teaching methodologies.

Although the ANOVA demonstrated overall differences among subject groups, paired comparisons found no statistically significant differences. The result indicated that personalized coaching reduced gaps in technology integration among different subject areas. The result corresponded with Kraft et al. (2018), whose meta-analysis revealed that personalized coaching could effectively support teachers in diverse contexts by addressing specific needs and promoting equitable development. Also, the insignificance between subject groups after coaching showed that effective coaching provided learning chances tailored to each teacher's situation, allowing them to use technology integration strategies consistently. This result aligned with Gibbons and Cobb (2017) and Knight (2007), who contended that coaching as a professional partnership enhanced capacity building across diverse teaching disciplines, ensuring that innovations such as digital technology were not limited to specific subjects but could be widely implemented with sufficient support.

Qualitative data results from interviews, reflections, and recommendations from primary school teachers and coaching experts on the integration of digital technology for learning revealed important issues reflecting the results of the coaching model development in four core areas, which are as follows. First, the coaching process enhanced teachers' confidence in selecting and implementing digital technologies in educational activities. These findings aligned with the studies conducted by Zimmer and Matthews (2022), which identified coaching as a vital form of professional development that empowered teachers to explore and implement new techniques, ultimately enhancing their self-efficacy. Similarly, Desimone and Pak (2017) also highlighted that sustained and content-focused coaching correlated with significant instructional modifications in instruction. Furthermore, the inclination toward technology, as seen in the use of PowerPoint, videos, games, and interactive tools, reflected broader patterns in primary education, where active and entertaining learning was crucial for maintaining student engagement (Kraft et al., 2018; Ruggiero & Mong, 2015). These findings highlighted the importance of integrating coaching with hands-on, context-specific digital literacy development to support teachers in designing engaging and effective lessons.

Second, the coaching process enhanced the development of teachers' TPACK-related competencies. The findings indicated that coaching significantly improved primary teachers' competency in integrating technological, pedagogical, and content knowledge into their educational practices. This result aligns with Knight (2007), who suggested that effective coaches should work as professional partners, and it is consistent with Chai et al. (2013), who indicated that significant TPACK development occurred when teachers were motivated to integrate all three knowledge domains into their teaching within authentic contexts. Additionally, it matched results from a recent study that showed primary teachers made great progress in their TPACK competencies after using a coaching model that focused on working together, hands-on practice, and thoughtful reflection. Similarly, Cowart and Jin (2024)'s case study of online professional development for instructional technology coaches identified coaching support, feedback, reflection, and collaboration as instrumental in building TPACK competency.

Third, these findings emphasized the necessity for a professional development model to transition from theoretical workshops to practice-based coaching that promotes teachers'

reflection, experimentation, and integration of technology in actual classrooms. The findings emphasized that deep reflection and collaborative analysis with coaches were essential for achieving significant professional growth. This supports Gibbons and Cobb (2017), who emphasized that coaching should provide guidance and create structured opportunities for teachers to reflect on and learn from their own teaching environments. Reflection facilitates the transformation of feedback into implementable strategies that improve practice. The transformation in teachers' perception of technology, from viewing it as an external tool to recognizing its essential role in lesson design, reflects the concept proposed by Chai et al. (2019). They contended that TPACK development must lead to the creation of high-quality, 21st century learning experiences that authentically integrate technology, pedagogy, and content.

Finally, despite the effectiveness of the coaching model, the study recommends conducting coaching at a reasonable pace. This aligns with Kraft et al. (2018) who emphasized that professional development needs to balance intensity with sustainability. Teachers must have the opportunity to reflect on and implement their acquired knowledge without succumbing to burnout.

Limitations

The scope of this study is specifically limited to fourth-grade primary school teachers within two districts under the Bangkok Education Office. While the DICT model demonstrates potential for enhancing digital competency, the findings are contextualized within this specific group and may not be immediately generalizable to secondary education or different regional contexts. Although the sample size comprised 64 participants the mixed-methods research design involved in-depth data collection (e.g., interviews/reflections), making the sample size sufficient for developing and evaluating the preliminary model. However, the sample size should be increased in the future for greater precision.

Recommendations and Future Research

Based on the findings and the aforementioned limitations, several recommendations are proposed. First, for effective practical application, educational stakeholders should consider expanding the implementation of the DICT model to other levels of teachers, including secondary schools and clusters of groups of schools within provincial contexts or in other provinces with different resources than Bangkok. To foster long-term sustainability, it is recommended that schools establish a continuous coaching system (longitudinal coaching) that extends beyond the initial two rounds. This would help transition the coaching process into a permanent professional learning community (PLC) within the school culture. Second, enhancing generalizability and precision in future research should focus on scaling up the study to include a larger and more diverse sample size across different provincial clusters. This expansion is essential to enhance the precision of the results and to evaluate the DICT model's adaptability in regions with different technological infrastructures than Bangkok. Finally, in methodological should employ experimental or quasi-experimental designs that include a control group. This would allow for a more rigorous comparison of teachers' digital competency development for the model's impact. Additionally, there is a need

for the development and validation of TPACK measurement tools specifically tailored for school-based action research, which would provide more nuanced data for classroom-level interventions.

Conclusion

The DICT model successfully improved the digital technology competence of 64 primary school teachers in a statistically significant group. The analysis of the data results showed that the average score of teachers' digital technology-based learning management behavior increased from ($\bar{x} = 2.22$, $SD = 0.39$) in the first supervision round to ($\bar{x} = 2.58$, $SD = 0.28$) in the second supervision round. The t-test results (Paired-sample t-test) confirmed the statistically significant difference at the .05 level $t(63) = 13.81$, $p < .05$. In addition, the ANOVA results showed the difference in competence according to professional level ($p = .020$) and subject group ($p = .026$) with statistical significance. This was particularly evident for the group of teachers within professional level (Level 1) who had a higher level of technology integration than other groups. These quantitative data, combined with qualitative analysis results, indicate that the DICT model not only enhances skills based on the TPACK framework but also fosters confidence and a positive attitude towards using technology in real classroom settings. While the study was localized within the Bangkok Education Office's primary schools, the success of the DICT framework underscores the power of personalized coaching in building teacher confidence and sustainable technological pedagogical knowledge. This research contributes to the broader educational landscape by offering a validated model that balances theoretical rigor with practical classroom application, ultimately paving the way for more resilient and digitally-capable teaching workforces in the future.

Author Contributions

KW: Conceptualization, Methodology, Software, Validation, Formal Analysis, Resources, Data Curation, Writing – Original Draft Preparation, Writing – Review and Editing. RR: Investigation, Visualization, Supervision, Project Administration, and Funding Acquisition.

Declaration of the Use of Generative AI

During the preparation of this manuscript, the authors used quillbot premium to assist with language editing and polishing of the draft. The tool was used solely to improve clarity, grammar, and overall readability. The authors reviewed and revised the output as necessary and take full responsibility for the content of the manuscript.

Ethics

This study received ethical approval from Office of the Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts, Approval No 670470. All procedures followed relevant ethical guidelines, and informed consent was obtained from all participants.

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