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## Artikel Publikasi Genap 2023-2024 Bu Yunita

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**Journal on English as a Foreign Language****Vol. 14, No. 1, March 2024, pp. 369-393**Journal homepage: <https://e-journal.iain-palangkaraya.ac.id/index.php/jefl>**Does teacher computer technology use perceived from TPCK frameworks stimulate student achievement in English language learning?****Annur Rofiq<sup>1,2</sup>, Utami Widiati<sup>1\*</sup>, Teguh Sulistyo<sup>3</sup>, Yunita Puspitasari<sup>4</sup>**<sup>1</sup>English Department, Faculty of Letters, Universitas Negeri Malang, Malang, Indonesia<sup>2</sup>Language and Arts Education Department, Faculty of Teacher Training and Education, Universitas Jember, Jember, Indonesia<sup>3</sup>English Language Department, Faculty of Language and Literature, Universitas PGRI Kanjuruhan Malang, Malang, Indonesia<sup>4</sup>Department of English Language Education, Faculty of Teacher Training and Education, Universitas PGRI Jombang, Jombang, Indonesia\*Email: [utami.widiati.fs@um.ac.id](mailto:utami.widiati.fs@um.ac.id) (corresponding author)**Article history:**

Received 15 January 2024; Revised 2 March 2024; Accepted 17 March 2024;

Published online 31 March 2024

**Abstract**

Studies on the relationship between teacher use of ICT and student achievement have been numerous, but those involving other intervening variables, such as technological, pedagogical, and content knowledge (TPCK), are still limited. This study examined the relationships between the use of computer technology (CT) by Indonesian EFL teachers and student achievement, taking into account the TPCK frameworks. Explanatory correlation serves as the research design, as this study was intended to explain the associations among variables under study. Data on teachers' CT use and students' English achievement were collected from a sample of 153 EFL teachers by means of Albirini's (2006) and Wozney et al.'s (2006) adopted questionnaire and the teachers' document of students' English achievement scores. The multiple regression analysis indicated that simultaneously, CT use, content knowledge (CK), pedagogical knowledge (PK), and pedagogical content knowledge (PCK) correlate slightly with student achievement,  $R^2 = .085$ ,  $F(4, 148) = 3.418$ ,  $p < .05$ . This finding suggests that the four predictor variables were not good at predicting student achievement. Other external factors not included in the model may relate to student achievement.

The study's findings imply that in teaching and learning English, teachers should play the role of CT facilitators and let students take great advantage of CT on their own.

**Keywords:** computer technology (CT); content knowledge (CK); English language learning; Indonesian EFL teachers; pedagogical content knowledge (PCK); pedagogical knowledge (PK); student achievement

**To cite this article:** Rofiq, A., Widiati, U., Sulistyo, T., & Puspitasari, Y. (2024). Does teacher computer technology use perceived from TPCK frameworks stimulate student achievement in English language learning? *Journal on English as a Foreign Language*, 14(1), 369-393. <https://doi.org/10.23971/jefl.v14i1.7821>

**To link to this article:** <https://doi.org/10.23971/jefl.v14i1.7821>



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## Introduction

The presence and advancement of computer technology (CT) have been greatly acknowledged in the area of education, resulting in teachers' adaptation and modification of teaching and learning paradigms and methods (Poudel, 2022). In the Indonesian context, CT opens various innovations offering improvement in the teaching and learning of English (Isnani, 2019). Most studies on teacher CT use have concluded that CT correlates with improved teaching and learning as well as student achievement (Balla, 2023; Hidayati, 2016; Isma, 2023; Nurmala et al., 2023; Poudel, 2022). However, CT does not stand by itself in improving teaching and learning. Teachers' knowledge of content, pedagogy, and strategies in delivering the content shares relevant roles in this context. Ortiz-Colón et al. (2023) believed that if properly integrated, teacher CT use, knowledge of content, pedagogy, and pedagogical content will result in teaching quality improvement. This current study stands on this claim for further investigating its relationship with student achievement.

Research on CT integration in teaching concerns mostly two aspects, namely quantitative aspects and qualitative aspects (Backfisch et al., 2021). Quantitative aspects of the research relate to, for example, the effect of CT use on student achievement (Silva et al., 2023; Simoes et al., 2022), while the qualitative aspects relate to, for example, weaknesses of ICT integration (Vieira & Pedro, 2023), information and communication technology (ICT) policies for education

(Alqahtani & Alqahtani, 2023). This current study on the relationship between CT and student achievement will enrich the quantitative aspects of the research on CT integration.

Side by side with the teacher use of CT, there are other teachers' characteristics that need to be taken into account, which also correlate with student achievement, such as teachers' knowledge of the subject matter (content knowledge – CK) and teachers' knowledge of pedagogy (pedagogical knowledge – PK). These three components, i.e., technology, pedagogy, and content, are well-known as technological pedagogical and content knowledge (TPACK), and if integrated appropriately, they could improve the quality of teaching and learning (Ortiz-Colón et al., 2023; Xu, 2015).

In fact, researchers' interest in teacher knowledge in education and technology has been sparked in recent years. One of the triggers for this interest is Schulman's work, which is considered to have led to an increased focus on research in this specific area (Konig, 2016). Among others, Mishra and Koehler (2006) further elaborated and expanded upon the teacher knowledge initially proposed by Shulman to address advancements in education and technology. This includes the formulation of pedagogical content knowledge (PCK) by Shulman, which has been extended to technological pedagogical content knowledge (TPCK).

However, to date, many studies on CT and TPCK of teachers and student learning outcomes have been predominantly centered around mathematics and science subjects (Abubakir & Alshaboul, 2023). For example, Kadioğlu-Akbulut et al. (2023) investigated the extent to which the use of ICT can predict science teachers' TPACK; Bretscher (2023) examined the TPACK construct within mathematics education; and Astari et al. (2023) studied pre-service-chemistry-teachers' ability in integrating CT in learning through Web-based TPACK scaffolding. Research gave little attention to the exploration of ESL/EFL teachers' PCK on a certain language skill, such as reading (Xu, 2015). Additionally, research that investigated teachers' TPCK in EFL teaching and learning of a specific language skill, for example, writing, is still very limited (Abubakir & Alshaboul, 2023).

In the Indonesian context, few studies have been conducted in the TPCK field. Among the few, the studies were dominated by measuring teachers' TPCK through self-report surveys (Mahdum, 2015) through the technological reflection integration matrix (Setiyanti & Hunt, 2017). Other studies focused on designing and evaluating TPCK measures (Chai et al., 2017; Thohir et al., 2022), and another study focused on the application of TPCK-oriented instructional designs in teaching practices (Cahyono et al., 2016). Measuring seventy-four in-service

senior high school English teachers' TPCK in Pekanbaru, Indonesia, Mahdum (2015) concluded that, in general, the teachers' TPCK was in a good category. They could integrate ICT, content, and pedagogy in language teaching. However, their technology-related sub-domains were lower than the non-technology sub-domains.

TPACK-oriented teaching practice, which improved the quality of EFL instructional designs and teaching practices, has been revealed by Cahyono et al. (2016). Training and facilitating twenty secondary school English teachers in designing and developing instructions, which involved a TPACK framework for sixteen sessions, the researchers concluded that teachers benefited a lot from the training, and they constructed instructional designs and implemented the teaching practices successfully.

Apart from the limited studies conducted in relation to TPCK in teaching English at secondary schools in the Indonesian context, understanding teachers' TPCK provides benefits to the betterment of EFL teaching and learning. These pieces of empirical evidence indicate that there is still room to investigate other perspectives, such as the relations between EFL teachers' TPCK and student achievement. It is obvious then that there is a need for more in-depth studies on the levels of teacher CT use covering such aspects as types, ways, and frequency and its relationship to students' EFL achievement. In addition, there are other factors that need to be considered: teacher knowledge factors comprising CK, PK, and PCK. Finding associations between teacher CT use and teacher knowledge (CK, PK, PCK) and student achievement will add and enrich significant empirical data and information to the body of research issues in this area. The current research, then, is intended to investigate answers to this question: "Is there any relationship among EFL teacher CT use, teacher CK, teacher PK, teacher PCK and students' achievement?" More specifically, this research question is broken down into these questions.

- (1) Is there any relationship between EFL teacher CT use and student achievement while controlling for CK?
- (2) Is there any relationship between EFL teacher CT use and student achievement while controlling for PK?
- (3) Is there any relationship between EFL teacher CT use and student achievement while controlling for PCK?

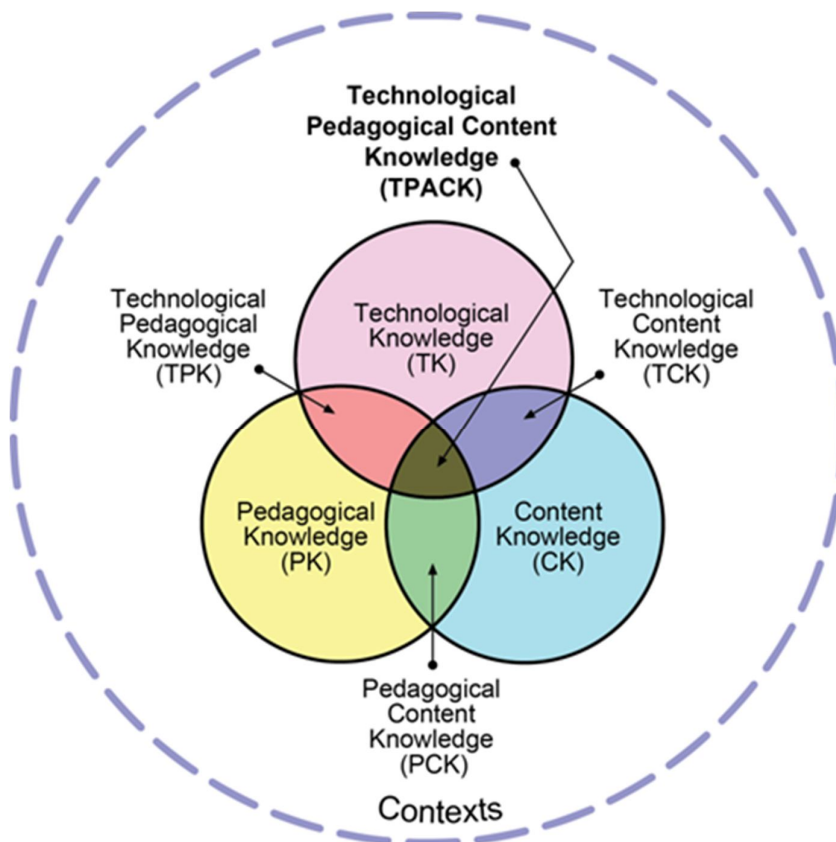
## Literature review

### *Concept of teacher knowledge*

Teachers, as one of the influential factors in student achievement, have attracted many studies in the last three decades. Teacher knowledge has become one of the main interests of many researchers. The growth of this specific research interest has been triggered by the influential work of Shulman (1986) on teacher's knowledge (Cueto et al., 2017; Konig, 2016). Mishra and Koehler (2006) are at the fore-end of today's research as they have elaborated and extended the teachers' knowledge first proposed by Shulman to respond to the advancement of education and technology (Shamim et al., 2024). Shulman's formulation of pedagogical content knowledge (PCK) has been extended into technological pedagogical content knowledge (TPCK) (Abbitt, 2011; Baser et al., 2015; Ortiz-Colón et al., 2023). This TPCK consists of seven domains: content knowledge (CK), pedagogical knowledge (PK), PCK, technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and TPCK (Graham, 2011; Kadioğlu-Akbulut et al., 2023). The TPACK framework is shown in Figure 1.

**Figure 1**

*The TPACK framework (source: <http://tpack.org>)*



As indicated in Figure 1, among these seven domains, CK, PK, and PCK are the distinguished knowledge used when evaluating teachers (Konig et al., 2016). Following the idea of Konig et al. (2016), this recent study focuses on these three domains of teacher knowledge. Mishra and Koehler (2009) define CK as the subject matter knowledge that a teacher is going to teach. This includes knowledge about theories, concepts, rules, etc. Within a certain subject (Graham, 2011). In addition, they define PK as the knowledge of the methods, processes, and practices of teaching and learning to be used in the classroom. This includes the techniques of teaching, the nature of the students, and the strategies for evaluating student learning (Konig et al., 2016). PCK is defined as the knowledge of transforming the subject matter in the best way so students can best understand it (Mahdum, 2015).

### ***Teacher computer technology (CT) use and student achievement***

Incorporating computer technology (CT) in the classroom is believed to improve learning, make learning more interesting, attractive, and appealing, and cultivate the students' problem-solving, communication, and research skills (Alieto et al., 2024). There are two reasons for using CT at schools: to help students advance their digital literacy needed for life in the 21<sup>st</sup>-century society and to improve the teaching and learning process (Paetsch et al., 2023).

Reviewing several findings of previous studies, Serrano-Mendizabal et al., (2023) summed up that computer systems are more advantageous than traditional classroom teaching in at least four areas. First, CT provides a broader set of learning materials and examples, leading to students' greater opportunities to practice (McNamara, 2010). Second, students become more self-regulated learners as they have control over their learning process (McNamara, 2010). Third, CT can accurately record students' activities in response to learning tasks, and teachers can provide timely feedback. Fourth, learning with CT seems to be more interesting, attractive, and motivating for students. In short, CT integration in education results in some possibilities to improve the quality of teaching and learning.

Apart from the promising advantages of CT in teaching, however, many teachers were found to use CT rarely during teaching at any level of education (Backfisch et al., 2021), and CT use at schools was also limited (Cabellos et al., 2024). This is due to the fact that, in line with the needs of CT in education, teachers still face hindrances in its implementation. Tømte et al. (2023) and Dai (2023) revealed two barriers that teachers faced, namely, external barriers, including availability and access to technological hardware and software, support from the institution, and development of competence through training,



and internal barriers covering teachers' knowledge, skills, and beliefs about technology integration. It is then worth investigating to what extent teacher use of CT correlates with student English achievement, taking into account the TPCK frameworks.

## Method

### *Research design*

An explanatory correlational research design (Creswell, 2019) was employed as this study aimed to explain the associations among the four predictor variables (teacher CT use, teacher CK, teacher PK, teacher PCK) and the criterion variable (student achievement). Naturally, explanatory correlational research is different from causal-comparative or cause-effect research. The latter tries to find the effect of one variable on the other, while the former tries to seek whether or not there are relationships between or among the variables and to explain the relationships. In other words, the design was in line with the objectives of this research, that is, investigating the relationships among EFL teacher CT use, teacher CK, teacher PK, teacher PCK, and students' achievement. This study did not intend to claim that one variable caused or affected another variable.

### *Participants*

The unit of this study was secondary school English teachers in one regency of the province of East Java, Indonesia. The population comprises 551 secondary school English teachers. This population spread in the east, west, north, south, and middle or city areas. Considering the widespread of the teachers and schools, convenient sampling was implemented to get the research sample (Creswell, 2019). The availability and accessibility of the respondents were the bases for the research participant selection. As many as 153 teachers voluntarily became the research participants. Getting these participants were very much facilitated through the regular meetings of the "subject teacher discussion forum" (the so-called MGMP or *Musyawah Guru Mata Pelajaran*) in the region. Teachers attending MGMP were quite representative of the population as they represented teachers from all the schools in the respective regions or areas. One to three teachers from each school attended the regular meetings. These 153 teachers provided English achievement test scores of their students. In total there were 5,127 secondary school students' scores obtained from the teachers. In other

words, on average, the 153 teachers each provided 34 student scores. The research participants' profile is shown in Table 1.

**Table 1**

*Research participants' profile*

Regions of schools	$\Sigma$ Population	$\Sigma$ Sample	%
Senior high school (no division)	116	35	22.88
East area	98	25	16.34
West area	78	23	15.03
North area	67	19	12.42
South area	108	27	17.65
City area	84	24	15.69
Total	551	153	100

### **Research instruments**

#### *Questionnaire on teacher CT use and teacher knowledge (TK)*

A questionnaire was the main instrument to collect the data on the EFL teacher CT use and TK. Three questionnaires were adopted and adapted in developing the questionnaire items related to teacher CT use. They were Albirini's (2006) *Attitudes Toward Computer Technology Questionnaire*, Wozney et al.'s (2006) *Technology Implementation Questionnaire*, and Hammond et al.'s (2011) *Teacher Beliefs and the Use of ICT Survey*. The questionnaire items related to CK, PK, and PCK were adopted from the questionnaire developed by Baser et al. (2015), as it was designed specifically for the EFL context.

The one-set questionnaire that was used in this current study consists of 60 items divided into six sections. Section One comprises six items about the participant's personal background. The teacher CT use is covered in three sections, namely skills and experiences in computer technology (Section Two), the process of integration (Section Three), and computer technology resources available (Section Four). Meanwhile, CK, PK, and PCK are covered in Section Five. The last section is intended for additional comments when the participants deem it necessary. Questionnaire items about teacher CT use and TK are presented in a four-Likert scale (1=No Competence, 2=Little Competence, 3=Moderate Competence, 4=Much Competence; 1=Never, 2=Once in a While, 3=Often, 4=Very Often; 1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree, respectively for Sections Two, Three, and Five), whereas Section Four is in a multiple-choice format. Meanwhile, Section Six is open-ended.

Prior to the use of the questionnaire, expert validation to ensure the content validity of the questionnaire was conducted. An expert from the Center for the



Study of learning and performance (CSLP), Concordia University, Canada, provided her evaluation of the questionnaire. Based on the evaluation, some word and phrase revisions were made to make the items more understandable—for example, item number 36. "What are your personal ownerships of computer technology/gadget?" was suggested to be "Do you own any computer devices?". This is an example of a multiple-choice item in which participants might select more than one alternative and write their own answer if they were not listed in the alternatives. Additionally, trying out of the questionnaire was administered to 40 EFL school teachers with similar characteristics to the sample. The Cronbach's alpha was found at .933 showing high reliability of the questionnaires.

### *Student achievement test*

In this current study, student achievement scores were obtained and collected from the participating English teachers. Students' achievement was measured using a teacher-made summative test developed by the team of teachers through MGMP by referring to the curriculum, syllabus, and lesson plans. All schools in the region used this teacher-made test. The teachers met regularly to discuss the development of the test to ensure test quality. The results of this summative test became the data for this research, comprising 5,127 scores of secondary school students from the 153 teachers involved in this study.

### **Data collection**

Before the questionnaire was distributed, online communication with the leader of the MGMP forum was carried out to explain what the study was about, what the data collection looked like, what was expected from the respondents, and how the data and information from the questionnaire were used. It was done to get permission to collect the data (Creswell, 2019). When the permission to collect data was granted, the date and time for data collection were arranged. The questionnaire was distributed to the participants during the regular MGMP meetings. As the questionnaire was handed directly to the respondents, the return rate of the questionnaire was very high. Almost all the paper-based questionnaires were returned, with very few being incomplete.

In order to get a larger number of respondents and to minimize the potential sampling error, the online version of the questionnaire was introduced during an MGMP meeting so that teachers who did not attend the MGMP meeting also had the opportunity to participate in the study by filling in the online questionnaire (Muijs, 2022). Finally, there were as many as 108 paper-based questionnaires and 56 online questionnaires collected. However, 7 paper-based and 4 online filled-

in questionnaires were not used in the data analysis as the respondents failed to answer the items completely and (or) they failed to provide the student achievement score, resulting in 153 responses analyzed.

### Data analysis

The data from the questionnaire were analyzed by means of the IBM SPSS Statistics. Multiple linear regression (Muijs, 2022) was used to find relationships among teacher CT use, teacher CK, teacher PK, and teacher PCK and student achievement, and then partial correlation (bivariate analysis) was used to find the relationships between CT use and student achievement while controlling CK, PK, and PCK respectively.

The data about student achievement in the form of scores were treated very carefully. It is essential to acknowledge that the students in each school experienced differences in their teaching and learning processes, evaluation, as well as learning facilities. To cope with these potential differences in student achievement, adjustment to the achievement test score was made by using standardized score averages, that is, the z scores. Reference to this issue goes to the work of Onwuegbuzie et al. (2000). They studied predictors of foreign language achievement, which comprise the cognitive domain, affective domain, personality, and demography. Their participants came from four different foreign language courses taught by different teachers with different teacher characteristics. The teachers also differed in teaching experience, motivation, testing, and scoring.

## Findings

### ***Relationships among EFL teacher CT use, teacher CK, teacher PK, teacher PCK, and student achievement***

The purpose of this study was to examine whether or not there is a relationship among the EFL teacher CT use, CK, PK, PCK as the predictor variables and student achievement as the criterion variable.

The multiple linear regression analysis was run to predict student achievement from teacher CT use, CK, PK, and PCK. The result showed that simultaneously, CT use, CK, PK, and PCK correlate with student achievement ( $p=.011<.05$ ). Table 2 shows the results of multiple linear regression analysis.

**Table 2**
*Results of multiple linear regression analysis*

ANOVA <sup>b</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1286.416	4	321.604	3.418	.011 <sup>a</sup>
	Residual	13926.643	148	94.099		
	Total	15213.059	152			

a. Predictors: (Constant), PEDCONT, COMP, PED, CONT  
b. Dependent variable: ACHIEV

The individual predictors (teacher CT use, CK, PK, PCK) were examined further to see the Beta coefficient correlation (Table 3). It was found that teacher CT use ( $t = 2.675$ ,  $p < .01$ ) was a significant predictor, while CK ( $t = -.094$ ,  $p > .05$ ), PK ( $t = .648$ ,  $p > .05$ ), and PCK ( $t = .563$ ,  $p > .05$ ) were not.

**Table 3**
*Beta coefficient correlations*

Coefficients <sup>a</sup>						
Model		Unstandardized coefficients		Standardized coefficients		Sig.
		B	Std. Error	Beta	t	
1	(Constant)	29.728	6.531		4.552	.000
	COMP	.164	.061	.223	2.675	.008
	CONT	-.011	.113	-.012	-.094	.926
	PED	.074	.114	.077	.648	.518
	PEDCONT	.074	.131	.076	.563	.574

a. Dependent variable: ACHIEV

Other results from data analysis revealed the Beta coefficient (Table 3), which represents the strength of the relationship between teacher CT use ( $\beta = .223$ ,  $p < .001$ ), CK ( $\beta = -.012$ ,  $p > .05$ ), PK ( $\beta = .077$ ,  $p > .05$ ), and PCK ( $\beta = .076$ ,  $p > .05$ ) and student achievement as well as the direction of the relationships. The results of this statistical analysis indicated that the value is merely useful to study the interconnection of the predictor variables and the criterion variable, but it is not useful for predicting the relationships (Creswell, 2019). From the multiple linear regression analysis and Beta coefficient correlation analysis, we can find a significant model,  $F(4, 148) = 3.418$ ,  $p < .05$ ,  $R^2 = .085$ .

Another important finding is that although the p-value for the regression as a whole was significant ( $p = .011$ ) when individual independent variables were observed, it was only the p-value of CT use which is significant ( $p = .008 < .05$ ),

while the p-value of the individual three predictor variables was not significant (p-value CK=.926>0.5, p-value PK=.518>0.5, p-value PCK=.574>0.5).

The next important step in the data analysis is to calculate how high the predictor variables (teacher CT use, CK, PK, and PCK) contribute to the criterion variable (student achievement). Table 4 shows the variables contributing to the criterion.

**Table 4**

*The variables contributing to the criterion*

Model	R	R square	Adjusted R square	Std. error of the estimate
dimension0 1	.291 <sup>a</sup>	.085	.060	9.70046

a. Predictors: (Constant), PEDCONT, COMP, PED, CONT

The "R Square" informs us how highly the predictor variables contribute to the criterion variable. In this study, the R Square value was .085 (8.5%), meaning that the predictors only contributed as much as 8.5% to the criterion, while the other 92.5% were the contribution of other factors. Additionally, the "Adjusted R Square" was .060. According to Muijs (2022), the value of "Adjusted R Square" <0.1 is considered to be a poorly fit for the model. This suggests that the four predictor variables did not predict student achievement well.

In summary, the multiple regression model with all four predictors (teacher CT use, CK, PK, and PCK) produced  $R^2 = .085$ ,  $F(4, 148) = 3.418$ ,  $p < .05$ . As we can see from the Beta coefficient correlation, the teacher CT use had significant positive regression weight (.223). This indicated students who had teachers with high scores on CT use were predicted to have higher scores on their achievement, after controlling for CK, PK, and PCK in the model. The other three predictor variables (CK, PK, and PCK) did not contribute to the model. From these results, we can have a multiple regression model of  $Y = 29.728 + 0.164comp + 0.011Cont + 0.074Ped + 0.074Pedcont$ .

#### ***Partial correlation between EFL teacher CT use while controlling for CK, PK, PCK, and student achievement***

A partial correlation was further calculated to examine the interaction between teacher CT use and student achievement while controlling for the other variables (CK, PK, PCK).

#### ***Correlation between teacher CT use and student achievement while controlling for CK***

When CK was controlled over the relationship between teacher CT use and student achievement, a correlation was found, as shown in Table 5.

**Table 5**

*Partial correlation controlling for CK*

Control variables			COMP	ACHIEV	CONT
-none <sup>a</sup>	COMP	Correlation	1.000	.261	.332
		Significance (2-tailed)	.	.001	.000
		Df	0	151	151
	ACHIEV	Correlation	.261	1.000	.174
		Significance (2-tailed)	.001	.	.031
		Df	151	0	151
	CONT	Correlation	.332	.174	1.000
		Significance (2-tailed)	.000	.031	.
		Df	151	151	0
CONT	COMP	Correlation	1.000	.219	
		Significance (2-tailed)	.	.007	
		Df	0	150	
	ACHIEV	Correlation	.219	1.000	
		Significance (2-tailed)	.007	.	
		Df	150	0	

Cells contain zero-order (Pearson) correlations.

From the analysis of this partial correlation (Table 5), it was known that a positive partial correlation with moderate strength of correlation existed between student achievement ( $49.92 \pm 10.00$ ) and teacher CT use ( $58.86 \pm 13.61$ ) whilst controlling for CK ( $77.94 \pm 11.68$ ), which was statistically significant,  $r(150) = .219$ ,  $N = 153$ ,  $p = .007$ . Without involving CK, however, there was a moderate, positive correlation, which was statistically significant, between student achievement and teacher CT use ( $r(151) = .261$ ,  $n = 153$ ,  $p < .001$ ). This indicated that CK had very little influence in controlling the relationship between student achievement and teacher CT use.

#### *Correlation between teacher CT use and student achievement while controlling for PK*

A correlation was found when PK was controlled over the relationship between teacher CT use and student achievement, as shown in Table 6.

From the analysis (Table 6), it was known that there was a moderate, positive partial correlation between student achievement ( $49.92 \pm 10.00$ ) and teacher CT use ( $58.86 \pm 13.61$ ) whilst controlling for PK ( $75.75 \pm 10.41$ ), which was statistically significant,  $r(150) = .224$ ,  $N = 153$ ,  $p = .005$ . Without involving PK, however, there was a moderate, positive correlation, which was statistically significant, between student achievement and teacher CT use ( $r(151) = .261$ ,  $n = 153$ ,  $p < .001$ ). This indicated that PK had very little influence in controlling the relationship between student achievement and teacher CT use.

**Table 6**
*Partial correlation controlling for PK*

Control variables			COMP	ACHIEV	PED
-none <sup>a</sup>	COMP	Correlation	1.000	.261	.267
		Significance (2-tailed)	.	.001	.001
		df	0	151	151
	ACHIEV	Correlation	.261	1.000	.183
		Significance (2-tailed)	.001	.	.023
		df	151	0	151
	PED	Correlation	.267	.183	1.000
		Significance (2-tailed)	.001	.023	.
		df	151	151	0
PED	COMP	Correlation	1.000	.224	
		Significance (2-tailed)	.	.005	
		df	0	150	
	ACHIEV	Correlation	.224	1.000	
		Significance (2-tailed)	.005	.	
		df	150	0	

a. Cells contain zero-order (Pearson) correlations.

### *Correlation between teacher CT use and student achievement while controlling for PCK*

When PCK was controlled over the relationship between teacher CT use and student achievement, a correlation was found, as shown in Table 7.

From the analysis (Table 7), it was known that there was a moderate, positive partial correlation between student achievement ( $49.92 \pm 10.00$ ) and teacher CT use ( $58.86 \pm 13.61$ ) whilst controlling for PCK ( $77.61 \pm 10.34$ ), which was statistically significant,  $r(150) = .222$ ,  $N = 153$ ,  $p = .006$ . Without involving PCK, however, there was a moderate, positive correlation which was statistically significant between student achievement and teacher CT use ( $r(151) = .261$ ,  $n = 153$ ,  $p < .001$ ). This indicated that PCK had very little influence in controlling the relationship between student achievement and teacher CT use.

## Discussion

### ***Relationships among teacher CT use, teacher CK, PK, PCK, and student achievement***

Computer technology (CT) has been a tool that stimulates teaching and learning more efficiently and effectively, more exciting and motivating to improve the

teaching-learning atmosphere and learning gain. This current study investigated the relationships among EFL teacher CT use, content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), and student achievement.

**Table 7**

*Partial correlation controlling for PCK*

Control variables			COMP	ACHIEV	PEDCONT
-none <sup>a</sup>	COMP	Correlation	1.000	.261	.281
		Significance (2-tailed)	.	.001	.000
		df	0	151	151
	ACHIEV	Correlation	.261	1.000	.185
		Significance (2-tailed)	.001	.	.022
		df	151	0	151
	PEDCONT	Correlation	.281	.185	1.000
		Significance (2-tailed)	.000	.022	.
		df	151	151	0
PEDCONT	COMP	Correlation	1.000	.222	
		Significance (2-tailed)	.	.006	
		df	0	150	
	ACHIEV	Correlation	.222	1.000	
		Significance (2-tailed)	.006	.	
		df	150	0	

a. Cells contain zero-order (Pearson) correlations.

The multiple linear regression analysis showed that the relationship among teacher CT use, teacher CK, PK, PCK, and student achievement was significant, but the coefficient correlation was low. The findings of this current study were in agreement with some of the literature and previous research findings that had been done in the last two decades. For example, Huang (2008), who investigated the use of CT in teaching, found that teacher use of CT could result in positive or negative relationships depending on how the teacher used it. When designing multimedia presentations poorly, students' attention was distracted, or even students misunderstood the lesson, resulting in a negative relationship between multimedia presentations and students' achievement. On the other hand, she found that teachers' computer activities (e.g., using computers to create instructional materials, using the Internet for colleague communication, and using computers to communicate with parents) had a significant positive relationship with students' reading achievement.

The integration of CT at schools did not always have positive effects on students' learning (Cabellos et al., 2024). Thomson (2013) surveyed 388 university



freshmen at a large Midwestern land grant university in the USA to gather data on technology use and revealed that some positive correlations between the use of digital technology and learning existed, and the coefficient correlation was small to moderate. The effects of CT use depend very much on how teachers implement CT in the classroom. In order to get benefits from CT, it is always important to consider in advance the most acceptable and appropriate strategy to deliver the teaching materials. In other words, teacher PK and PCK should support the integration of CT.

Based on the results of multiple linear regression measures, none of these three predictor variables (CK, PK, PCK) have relationships with student achievement. Though these findings contradict the theory, some previous studies ended up with non-significant correlations. The finding of a previous study done by Fung et al. (2017) indicated that students' achievement outcome (in Math) was not affected by teachers' subject matter knowledge but by teachers' educational efficacy. Baumert et al. (2010) also found that CK had lower predictive power for student progress (cognitive activation and individual learning support) in studying mathematics. On the other hand, Baumert and Kunter (2013) claimed that PCK had a large positive impact on students' learning achievement. Meanwhile, Callingham et al. (2016) concluded that CK alone was not adequate for positive learning gain for the students. It was the PCK that was determining. Gess-Newsome et al. (2017) revealed that only academic content knowledge (ACK) was likely to affect student learning. It is very interesting to know that only the teacher CT use correlated with the student achievement, though the correlation was low; meanwhile, teacher CK, PK, and PCK did not show any correlation.

A reasonable speculation about these phenomena is that today's students as "digital native" learners are those who learn differently from those students before their generation (Thompson, 2013). They are familiar and have relatively easy access to CT (Kolikant, 2010). Accordingly, today's students are self-sufficient learners, and they learn more from other varieties of sources than what they can get from schools. CT provides students with rich learning resources which might be more appealing than what the textbooks and the teacher can provide.

A study by Schmitt and Wadsworth (2006) supported this phenomenon. The study revealed that among British youths aged 16 to 18, there was a significant positive association between personal CT ownership and their learning achievement measured by GCSEs and A-levels. Also, a study by Huang (2008) confirmed this finding that there were positive significant correlations between students' academic achievement (in Math and Reading) and student's home



access to computers, i.e., when the family has a computer and access to the Internet. A study by Vigdor et al. (2014) strengthened these claims that the introduction of home CT showed a modest and statistically significant association with student math and reading scores. Indeed, students who used CT at home, supported with the home environment, have better learning achievement at school (Simoes et al., 2022).

As digital natives, today's students were raised in a technology-rich environment and were likely to possess technology-related skills. Their skills in using CT could be used to access learning resources from the Internet worldwide (Hall & Lundin, 2024). They could get many benefits from digital technology (Kolikant, 2010). These open a great deal of opportunities for students to learn in a way that fits their personal learning style.

To conclude, the findings from this study confirmed the theory and findings of previous studies, which showed a significant interaction between teacher use of computer technology and student achievement. In this current study, teacher use of CT, teacher CK, PK, and PCK significantly correlate positively with student achievement. As the study findings revealed that CT use, CK, PK, and PCK contributed only as much as 8.5% to the student's achievement, future studies may seek other factors which contributed more to the student's achievement.

This current study revealed that simultaneously the teacher CT use, supported with teacher CK, PK, and PCK correlate significantly with student's English achievement though the strength of the correlation was very weak ( $\beta = .223$ ). Such value simply indicated the interconnection of the predictor variables and the criterion variable, but not useful for predicting the relationship (Creswell, 2019).

The findings of this study contribute to effective teaching and learning in the case that in the teaching and learning English teachers should play a role as facilitators of "learning with computer" and let the students take great advantage of the computer technology on their own. "Learning about computers" seems irrelevant to the students who are naturally digital natives. Teacher CT use, CK, PK, and PCK must be in accordance with the characteristics of the students and meet the needs of students' learning.

The limitations of this study were basically related to the data collection methods. First, though carefully developed and administered, the questionnaire which was used to collect the data on teacher CT use, CK, PK, and PCK might not provide reliable data. The responses given by teachers as participants of this research might be subjective and biased towards the researcher and their colleagues. Future researchers are suggested to measure teacher CT use, CK, PK,

and PCK conducting classroom observation in addition to administering a questionnaire. Secondly, student achievement scores on English subject were obtained from the teachers. However, the test used was the same throughout the schools, i.e., the one developed by the "subject teacher discussion forum" (MGMP), and the raw scores were used in the data analysis. However, the teaching and learning activities conducted by teachers were different from one school to another, resulting in differences in students' English learning experiences as well. That is why future researchers are suggested to measure English achievement by using a standardized English test whose validity and reliability have been proven. Indeed, these limitations might impact the reliability of the findings.

## Conclusion

This study aimed to reveal the relationship among EFL teacher CT use, teacher CK, teacher PK, teacher PCK and students' achievement as a whole and in partial. The multiple linear regression analysis indicated that teacher use of CT, teacher CK, PK, and PCK correlate with student achievement. Looking at the effect size in which the strongest Beta coefficient is on teacher use of CT ( $\beta = .223$ ), the relationships among the variables are only slight. In other words, the findings of this study reveal interconnections among the variables, but predictions of the relationships cannot be strongly established.

Partial correlation is used to analyze the relationship between teacher CT use and student achievement while controlling for teacher CK, PK, and PCK. The statistical analysis reveals that there is a positive partial correlation between teacher CT use and student achievement whilst controlling for CK, PK, and PCK. This study's findings confirmed previous studies' theory, which showed a significant interaction between teacher use of CT and student achievement. Considering the value of the correlation coefficient, CK, PK, and PCK have very little influence in affecting such a relationship. In other words, the four predictor variables are not good at predicting the criterion variable. This does not mean that teaching computer use, knowledge about the subject to teach, knowledge about how to teach, and knowledge about how to teach the subject are not important for instructional activities.

The findings indicate that in this so-called digital era, where information and communication in a network environment dominate, teachers are not the premier source of information for student learning. Rather, they are facilitator and guide to the student's learning. A reasonable explanation for this phenomenon is that

our today's students are those who learn differently from those students before their generation. Born as the "digital natives", today's students have a variety of ways to fulfill their learning needs. They are self-sufficient learners, and they learn more from other variety of sources than what they can get from schools. Computer technology provides students with rich learning resources that are more appealing than the textbooks and the teacher can provide.

The findings of this research also carry some implications for the teaching and learning of English, especially when it involves computer technology use. First, teachers are supposed to be facilitators of students' use of computer technology who direct and lead students to appropriate and meaningful learning experiences. Second, realizing that today's students are mostly familiar with how to use computer technology, teaching, and learning activities, to a large extent, should optimize the use of computer technology as a tool to deliver the lesson and as a source of learning materials.

Future researchers are suggested to measure teacher CT use, CK, PK, and PCK by conducting classroom observation in addition to administering questionnaires. Additionally, students' achievement scores should be obtained by conducting an English achievement test using standardized English tests. These two ways of data collection will at least improve the validity and reliability of the research findings due to the limitations of this current research related to data collection.

## Acknowledgments

We are extremely grateful to our colleague Shirly Rizki Kusumaningrum for her immense efforts in organizing and managing the data and proofreading this manuscript.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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Rofiq et al. Does teacher computer technology use perceived from TPCK frameworks

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*Journal on English as a Foreign Language*, 14(1), 369-393  
p-ISSN 2088-1657; e-ISSN 2502-6615