ESL Lecturers' Digital Competence and Organizational Support and Their Effect on Pedagogical Digital Competence

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***Abstract*—The rapid integration of digital tools in higher education has introduced significant challenges for lecturers, particularly in meeting increasingly diverse student needs and instructional expectations. This quantitative study investigates the influence of both individual digital competence and organizational support on English as a Second Language (ESL) lecturers' Pedagogical Digital Competence (PDC), using data from 233 participants in Malaysian higher education institutions. The findings reveal a strong association between lecturers' digital competence and their PDC, while also highlighting that organizational support, particularly professional development, plays a critical role. However, institutional infrastructure and leadership, though important, were not independently predictive of PDC without targeted professional learning. This study addresses a notable gap in the literature by focusing on ESL lecturers in Malaysia and integrating the Technological Pedagogical Content Knowledge (TPACK), Teacher's Digital Competence, and E-Capacity models to offer a more holistic understanding of PDC development. The insights contribute practical implications for institutions aiming to enhance digital pedagogy and support digital transformation in teaching.**

***Keywords*—digital competence, English as a Second Language (ESL) lecturers, higher education institution, organizational support, pedagogical digital competence**

I. Introduction

The rise of digital technologies has significantly transformed the higher education landscape in Malaysia. Institutions are increasingly integrating pedagogical digital competence into teaching practices. The Ministry of Higher Education Malaysia [1] emphasizes that the Fourth Industrial Revolution (4IR) is transforming the educational landscape by shifting tasks once performed by humans to technology-driven systems [2]. This evolution presents both opportunities and challenges, particularly for lecturers who must adapt to new pedagogical expectations [3–5].

Although there is substantial investment in digital education initiatives, empirical evidence on their effectiveness remains mixed [6, 7]. Many studies indicate that digital tools often support, rather than transform, traditional pedagogies [8]. Moreover, lecturers frequently lack the advanced skills needed to maximize digital teaching tools, with only a minority reaching high levels of integration [9–11]. As reliance on digital platforms grows, it becomes increasingly important for lecturers to upskill and adapt to ongoing technological shifts [12, 13].

Previous studies on digital literacy emphasized on the role of educational institutions in defining, developing, and maintaining "digital citizenship (digital citizen refers to a person utilizing Information Technology (IT) in order to engage in society, politics, and government initiatives)" [14, 15]. There are also studies on the role of students in the classroom [16, 17]. In the meantime, Lund [18], Røkenes and Krumsvik [19], Jalkanen [20], Krumsvik *et al.* [11], and Instefjord [21] looked at different facets of lecturers' digital competency as well as their role in a digital literacy environment. Nevertheless, these observations of lecturers' digital competency and their role of lecturers have yet to be looked at in depth, as Krumsvik *et al.* [11] and Instefjord [21] looked at the lecturers' own evaluation of their digital skills, but more depth findings can be made by looking at educators from a specific background. Even with two different studies looking at the use of digital tools in a student learning environment [22, 23], research on the digital competency of lecturers in Malaysia remains limited—especially regarding English as a Second Language (ESL) lecturers' digital competence. More broadly, Southeast Asian education systems face similar challenges, with inconsistent training and infrastructural deficits hindering the integration of digital pedagogy [24]. These regional trends underscore the importance of examining both individual and organizational factors influencing lecturers' digital competence.

This paper presents a novel investigation into ESL lecturers' pedagogical digital competence by integrating the Technological Pedagogical Content Knowledge (TPACK), Teacher Digital Competence, and E-Capacity models, offering a context-specific analysis in the Malaysian higher education environment. To bridge existing gaps in literature, this study investigates two central research questions:

1) What is the relationship between ESL lecturers' digital competence and their Pedagogical Digital Competence (PDC)?
2) What is the relationship between organizational support (professional development, organizational infrastructure, and strategic leadership) and ESL lecturers' PDC?

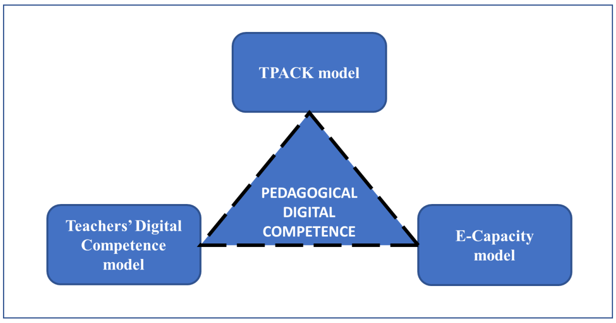

Fig. 1. Theoretical framework of the study (Source: Author's own work).

Anchored with TPACK model, this study (see Fig. 1) illustrates the theoretical framework with Teachers Digital Competence model and E-Capacity model. The primary component of PDC is the capacity to enhance pedagogical features with the utilization of digital technologies in the specialized sense, mainly in the online teaching context.

This study utilizes a blended framework incorporating TPACK, the Teacher Digital Competence model, and the E-Capacity model. TPACK emphasizes context-sensitive integration of content, pedagogy, and technology [25], while E-Capacity highlights institutional readiness and infrastructure as catalysts for digital change [26]. Complementing these is Krumsvik's [12] model, which focuses on the formation of lecturers' digital competence, including their ability to support learning strategies and engage with digital content critically and didactically. This model specifically focuses on the lecturers' actual digital competence and the way it is formed. The model also highlights the importance of digital skills, lecturers' understanding ways to facilitate the students' learning strategies, the didactic knowledge of the subject matter as well a fourth relevant skill of teaching the students the ways to communicate and source knowledge from the online world. Therefore, this study aims to examine the relationship between ESL lecturers' digital competence—which includes basic digital skills, didactic Information and Communications Technology (ICT) competence, learning strategies, and digital Bildung—and components of the E-capacity model such as professional development, organizational infrastructure, and strategic leadership in relation to Pedagogical Digital Competence (PDC). Additionally, it seeks to explore how ESL lecturers adopt, adapt, appropriate, and innovate in their use of PDC in classroom instruction, ultimately proposing a framework to guide the development of digital competence among ESL lecturers.

In summary, the theoretical model offers a comprehensive explanation of the key dimensions of pedagogical digital competence, addressing them both individually and collectively. By incorporating the macro-level elements of the E-capacity model and the micro-level components of the teacher's digital competence model, the framework presents a more integrated perspective for examining the development of lecturers' digital competence within the Malaysian higher education context.

II. Literature Review

The following section provides a review of key academic literature relevant to this study, highlighting emerging issues concerning ESL lecturers' digital competence and the influence of organizational support on their Pedagogical Digital Competence (PDC).

A. Pedagogical Digital Competence

The changing educational context, especially in the higher education system, reflects the progressive state of society as well as the growing importance of ICT and the emergence of ICT-based education. Laurillard [27] posited that the utilization of ICT can resolve the existing pedagogical issues with respect to the circumstances of these issues present. Meanwhile, Schneckenberg [28] asserted that it has become necessary for an upward revaluation in the pedagogical approaches of HEI vis-à-vis their research practices. Therefore, the primary component of PDC is the capacity to enhance pedagogical features with the utilization of digital technologies in a specialized sense, mainly in the online teaching context. Nevertheless, PDC broadly encompasses different pedagogical features pertaining to the utilization of digital technologies which includes conceptual knowledge and practical knowledge that can be trained and enhanced Pedagogical Digital Competence (PDC) plays a crucial role in enhancing students' learning experiences, and lecturers' effectiveness can be evaluated through their choice of instructional strategies in the classroom. Contextually, researchers such as Wastiau *et al*. [9] and from [3] have undertaken multiple efforts to evaluate the pedagogical components of digital competence. One notable example is the European DigCompEdu framework, which highlights both the professional and pedagogical aspects of educators' digital skills [29]. Therefore, this study will comprehensively involve in assessing and ensuring the necessary technological integration and enhancing the digital competence of lecturers towards PDC concept in the HEI setting.

B. Teachers Digital Competence Model

Referring to the Teacher's Digital Competence model, there are four primary constructs of digital competence that are based on one another to a certain degree. These fundamental components are: (i) basic ICT skills; (ii) didactic ICT-competence; (iii) learning strategies; and (iv) digital bildung (cultivating learners' ability to critically and responsibly use digital resources) [12]. These components are described as follows:

H1: Basic Digital Skills has a significant relationship with Pedagogical Digital Competence.

H2: Didactic ICT Competence has a significant relationship with Pedagogical Digital Competence.

H3: Learning Strategies has a significant relationship with Pedagogical Digital Competence.

H4: Digital Bildung has a significant relationship with Pedagogical Digital Competence.

H5: Teacher's Digital Competence Model has a significant relationship with Pedagogical Digital Competence.

C. E-Capacity Model

This model looks at the organization's role to create teacher level and organization level that catalyst use of technology and bring change in attitude surrounding its use. Both these teacher level and organization level support are brought together and highlighted in this model.

Even though research on students' participation in the classroom has been conducted, the lecturers' roles and the variables influencing their digital competency has not been extensive research in the classroom digital competence setting [16, 17]. The E-capacity model emerged from a school improvement perspective, framing E-capacity as a broad concept that reflects an institution's ability to establish and sustain effective conditions—both at the school and teacher levels—for meaningful ICT integration.

Contextually, scholars such as Vanderlinde and Braak [26], Wastiau [9], and from [3] have made significant efforts to evaluate the pedagogical dimensions of digital competence. From [3] specifically argues that these pedagogical aspects encompass not only the individual capacities of educators but also the institutional support provided by their organizations. Likewise, the presence of robust organizational infrastructure, well-developed policies, and effective strategic leadership are essential for achieving educational goals through educators' teaching practices [26]. These elements play a critical role in facilitating technological integration and strengthening educators' digital competence [9]. Given the multifaceted nature of digital competence in educational settings, both its development and assessment remain inherently complex.

H6: Professional Development has a significant relationship with Pedagogical Digital Competence.

H7: Organizational Infrastructures has a significant relationship with Pedagogical Digital Competence.

H8: Strategic Leadership has a significant relationship with Pedagogical Digital Competence.

H9: E-Capacity Model has a significant relationship with Pedagogical Digital Competence.

To better illustrate the complementary roles of institutional and individual factors in shaping pedagogical digital competence, Table 1 presents a side-by-side comparison of the E-Capacity Model and the Teacher's Digital Competence Model. This comparison highlights how both organizational support and lecturer digital proficiency are essential for effective digital integration in ESL contexts.

Table 1. Comparison of the e-capacity model and the teacher's digital competence model

Feature	E-Capacity Model [26]	Teacher's Digital Competence Model [12]
Primary Focus	Institutional/Organizational support for digital integration	Individual teacher's digital proficiency and pedagogical application
Level of Influence	Macro-level (system-wide: school/university infrastructure, leadership)	Micro-level (lecturer's knowledge, skills, and digital practice)
Key Constructs	-Professional Development-Organizational Infrastructure-Strategic Leadership	-Basic Digital Skills-Didactic ICT Competence-Learning Strategies-Digital Bildung
Assumptions	Effective digital integration depends on enabling school conditions	Teacher's pedagogical effectiveness relies on their digital competence
Contextual Application	Broad application across educational institutions	Focused application in classroom instructional contexts
Measurement Focus	Availability and quality of institutional resources, policy, and support	Self-reported or observed digital skillsets and pedagogical integration
Strength	Highlights need for institutional investment and leadership vision	Captures pedagogical depth of digital technology use
Limitation	May overlook individual readiness or motivation	May underestimate external/institutional constraints
Relevance to ESL Lecturers	Emphasizes the systemic support needed to sustain digital teaching	Emphasizes the skills lecturers must acquire to use technology meaningfully

D. Conceptual Framework

This study employs a dual-framework approach, illustrated in Fig. 2, which integrates the Teacher's Digital Competence Model [12] with the E-Capacity Model [26]. These two models serve as complementary lenses: the former concentrates on individual educator competencies—such as basic digital skills, didactic ICT competence, learning strategies, and digital Bildung—while the latter emphasizes institutional preparedness through professional development, infrastructure, and strategic leadership. Combined, they provide a comprehensive framework for examining ESL lecturers' pedagogical digital competence within the Malaysian higher education landscape.

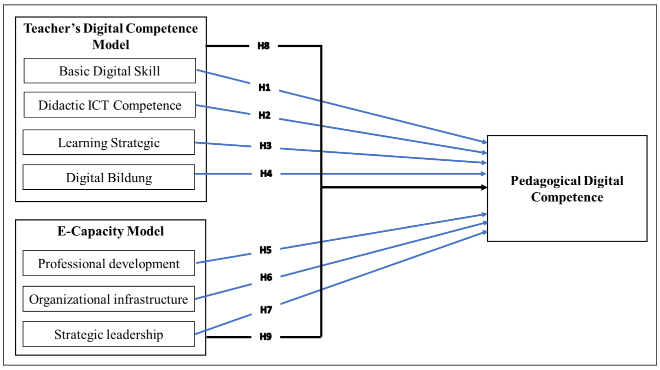

Fig. 2. Conceptual framework of the study (Source: Author's own work).

III. Materials and Methods

This study focused on private universities and colleges to look at how these organizations implement and create technology-oriented setting at their institutions. These two states were selected because most higher institutions are located here, which translates to 70% of universities (33 from 47) and 47% college universities (16 from 34). This study employed a simple random sampling technique, targeting senior lecturers, lecturers, and junior lecturers as the main units of analysis. Based on the sample size determination table by Krejcie and Morgan [30], 233 ESL lecturers were selected, resulting in a response rate of 61.4%. Utilizing quantitative research design, data were collected through a structured survey and analyzed using statistical methods such as factor analysis, Pearson correlation, and multiple linear regression. Each research question was aligned with specific constructs and corresponding analytical procedures.

This research was ethically approved by the Universiti Kebangsaan Malaysia Research Ethics Committee. Prior to participation, all respondents gave informed consent to be involved in the study.

The questionnaire comprises nine sections, namely, (1) demographic characteristics and personal characteristics, (2) professional characteristics, (3) professional development, (4) organizational infrastructures, (5) strategic leadership, (6) basic digital skills, (7) didactic ICT-competence, (8) learning strategies, (9) digital Bildung and (10) Pedagogical Digital Competence. All items were measured using a six-point Likert scale ranging from "strongly disagree" to "strongly agree."

IV. Results

This section presents the analysis of data gathered from 233 completed survey questionnaires. Initially, the raw responses were organized to extract relevant information. Subsequent analyses involved various descriptive procedures, including the examination of respondent demographics, assessment of data normality, evaluation of reliability using SPSS version 25.0, and hypothesis testing.

A. Respondents' Demographic Profile

A summary of the demographic information on the representatives of the sample of ESL lecturers is presented in Table 2.

Table 2. Demographic profile of respondents

Demographic Variables		Frequency	%	Cum. (%)
Gender of respondent	Male	47	20.2	20.2
	Female	186	79.8	100.0
	Total	233	100.0	
Age of respondents	21 to 30 years	43	18.5	18.5
	31 to 40 years	113	48.5	67.0
	41 to 50 years	50	21.5	88.4
	51 to 60 years	27	11.6	100.0
	Total	233	100.0	
Ethnicity	Malay	136	58.4	58.4
	Chinese	51	21.9	80.3
	Indian	26	11.2	91.4
	Others	20	8.6	100.0
	Total	233	100.0	
Marital Status	Single	87	37.3	37.3
	Married	138	59.2	96.6
	Divorced	7	3.0	99.6
	Widowed	1	0.4	100.0
	Total	233	100.0	
Salary	RM1000 to RM3000	34	14.6	14.6
	RM3001 to RM5000	123	52.8	68.2
	RM5001 to RM7000	53	22.7	91.0
	RM7001 and above	21	9.0	100.0
	Total	233	100.0	
Gadget owned	1	10	4.3	4.3
	2	110	47.2	51.5
	3	69	29.6	81.1
	4	27	11.6	92.7
	Over 4	17	7.3	100.0
	Total	233	100.0	
Average use per day	0 to 2 h	5	2.1	2.1
	2 to 4 h	44	18.9	21.0
	4 to 6 h	55	23.6	44.6
	6 to 8 h	54	23.2	67.8
	8 to 10 h	43	18.5	86.3
	10 to 12 h	22	9.4	95.7
	Over 12 h	10	4.3	100.0
	Total	233	100.0	
English language teaching experience	1 to 2 years	13	5.6	5.6
	3 to 5 years	31	13.3	18.9
	5 to 10 years	87	37.3	56.2
	Above 10 years	102	43.8	100.0
	Total	233	100.0	
Education level	Diploma	1	0.4	0.9
	Degree	63	27.0	27.9
	Master	152	65.2	93.1
	PhD	16	6.9	100.0
	Total	233	100.0	
Academic position	Junior lecturer	22	9.4	9.4
	Lecturer	171	73.4	83.3
	Senior lecturer	39	16.7	100.0
	Total	233	100.0	
Students teaching level	Diploma	28	12.0	12.0
	Foundation	50	21.5	33.5
	Degree	155	66.5	100.0
	Total	233	100.0	
Formal ICT education	No formal ICT education	109	46.8	46.8
	15 credits or less	107	45.9	92.7
	16 to 30 credits	12	5.2	97.9
	31 to 60 credits	5	2.1	100.0
	Total	233	100.0	
Continuing ICT education	Yes	37	15.9	15.9
	No	196	84.1	100.0
	Total	233	100.0	

A majority of the ESL lecturers or 79.8% are females, whereas only 20.2% are male. From this sample, a majority of them or 48.5% are 31 to 40 years old. This is followed by 21.5% of 41 to 50 years, 18.5% of 21 to 30 years and finally 11.6% of 51 to 60 years. The highest respondents' ethnicity is Malay (58.4%), followed by Chinese (21.9%), Indian (11.2%) and others (8.6%). Half of the sampled respondents are married (59.2%), single (37.3), divorced (3.0%) and others (0.4%). In view of salary earned, 52.8% of the respondents earned between RM3001 to RM5000, followed by 22.7% respondents earned between RM5001 to RM7000, 14.6% respondents earned between RM1000 to RM3000 and 9.0% of the respondents earned above than RM 7001. Looking at the number of gadgets owned, a majority of the ESL lecturers or 47.2% had 2 gadgets, trailed by 29.6% who had 3 gadgets, 11.6% who had 4, 7.3% of the respondents had over 4 gadgets while the minority was those who had only 1 at 4.3%. If the number of gadgets was correlated to the average screen time per day, a majority or 46.8% of the ESL lecturers utilized between 4 to 8 hours. This is followed by 18.9% utilizing 2 to 4 hours, 18.5% utilizing 8 to 10 hours, 9.4% utilizing 10 to 12 hours and finally a minority of 4.3% and 2.1% utilizing above than 12 hours and below 2 hours respectively. n terms of teaching experience, 43.8% of ESL lecturers had over 10 years of experience, while 37.3% had between 5 and 10 years. A smaller group, 13.3%, reported 3 to 5 years of experience, and only 5.6% had less than 2 years of teaching practice. Regarding academic qualifications, the majority held a Master's degree (65.7%), followed by Bachelor's degree holders (27.0%), PhD holders (6.9%), and a minimal number with a diploma (0.4%). As most of the respondents hold Master degree, nearly three quarter of them held lecturer position in their respective university followed by senior lecturer position (16.7%) and junior lecturer position (9.4%). Based on the education level and academic position, about 66.5% of the respondents taught Degree level students, whereas 21.5% taught Foundation level students and 12.0% taught Diploma level students. When queried about their background in ICT education, it is noteworthy that 46.8% of ESL lecturers reported having no formal training in ICT. Meanwhile, 45.9% had undertaken limited exposure, completing 15 credits or fewer. Only a small proportion had received more extensive training, with 5.2% completing 16 to 30 credits and just 2.1% attaining 31 to 60 credits. Interestingly, despite this limited formal training, a significant majority (84.1%) expressed no intention to pursue further ICT education, while only 15.9% indicated plans to enhance their digital skills through formal education.

B. *Test of Normality*

The study applied parametric statistical methods, specifically descriptive statistics and factor analysis. These techniques are appropriate when the dataset follows a normal distribution and demonstrates consistent variance across samples. Table 3 presents the distribution values supporting this assumption. The analysis also affirms that the mean and standard deviation values across the eight variables exhibit patterns indicative of a normal distribution.

The skewness and kurtosis values for all variables were within the acceptable threshold of −1.96 to +1.96, as suggested by Doane and Seward [31], indicating no major deviations from normality that could compromise standard error accuracy [32]. To validate this further, both the Kolmogorov-Smirnov and Shapiro-Wilk tests were conducted. The Shapiro-Wilk test produced significance values above 0.05, supporting the assumption that the data were normally distributed [33] confirming that the dataset followed a normal distribution. This outcome supported the use of SPSS for analysis, given its effectiveness under conditions of approximate normality [34, 35]. Therefore, the study proceeded with parametric methods appropriate for normally distributed data.

Table 3. Test of normality

Variables	Mean	Standard Deviation	Skewness	Kurtosis	Shapiro-Wilk	Sig
Professional Development	27.35	3.97	−0.472	0.427	0.979	0.002
Organizational Infrastructures	34.42	8.20	−0.299	−0.459	0.978	0.001
Strategic Leadership	20.06	5.87	−0.259	−0.595	0.971	0.000
Basic Digital Skills	24.27	3.97	−0.669	0.957	0.952	0.000
Didactic ICT Competence	26.84	5.03	−0.648	0.584	0.961	0.000
Learning Strategies	17.06	3.98	−0.499	0.268	0.971	0.000
Digital *Bildung*	19.00	3.69	−0.774	0.206	0.940	0.000
Pedagogical Digital Competence	23.46	3.45	−0.261	−0.376	0.979	0.002

C. Goodness of Measure

Before conducting the multivariate analysis, the study evaluated the quality of its measurement instruments through assessments of validity and reliability. The outcomes of these evaluations are presented in the subsequent sections.

D. Factor Analysis

Principal Component Analysis (PCA) was utilized in this study to uncover and extract latent factors within the dataset. As a dimensionality reduction technique, PCA facilitates the construction of new factor structures while preserving the maximum amount of original variance [36]. To determine the appropriateness of the data for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity were performed. The results, including eigenvalues greater than 1.0, are summarized in Table 4 and demonstrate sufficient intercorrelation among variables to justify the use of PCA.

Table 4. KMO and Bartlett's test of sphericity

Test Statistic		Result
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.919
Bartlett's Test of Sphericity	Approx. Chi-Square	7451.646
	df	903
	Sig.	0.000

E. Total Variance Explained

In accordance with Kaiser's criterion, only factors with eigenvalues equal to or greater than 1.0 were retained for further analysis. As shown in Table 5, eight components met this criterion, collectively explaining 69.4% of the total variance. Among these, the first component contributed 36.0%, the second 11.9%, and the third 5.2% to the overall variance.

Table 5. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.515	36.082	36.082	15.515	36.082	36.082	8.470	19.698	19.698
2	5.116	11.898	47.979	5.116	11.898	47.979	7.477	17.389	37.087
3	2.240	5.210	53.189	2.240	5.210	53.189	3.361	7.817	44.904
4	1.845	4.290	57.480	1.845	4.290	57.480	3.154	7.335	52.239
5	1.576	3.665	61.145	1.576	3.665	61.145	2.295	5.337	57.576
6	1.373	3.192	64.337	1.373	3.192	64.337	2.198	5.112	62.688
7	1.135	2.640	66.976	1.135	2.640	66.976	1.498	3.484	66.171
8	1.037	2.411	69.387	1.037	2.411	69.387	1.383	3.216	69.387
9	0.965	2.243	71.630						
10	0.889	2.068	73.698						
…	…	…	…						
42	0.109	0.252	99.797						
43	0.087	0.203	100.000						

Extraction Method: Principal Component Analysis.

Hence, the total variance explained analysis indicated that up to eight components could be extracted from the combined dataset.

F. Rotated Component Matrix

The assessment of constructs, namely Professional Development, Organizational Infrastructures, Strategic Leadership, Basic Digital Skills, Didactic ICT Competence, Learning Strategies, Digital Bildung, and Pedagogical Digital Competence—was conducted using 43 items rated on a six-point Likert scale. Principal Component Analysis (PCA) with Varimax (orthogonal) rotation was applied to extract the factors. As shown in Table 6, the results demonstrated acceptable convergent validity, with all retained items loading above the 0.50 threshold on their respective constructs [37]. Items with loadings below this benchmark were excluded to ensure clearer and more interpretable factor structures.

A total of eight items were removed during the analysis. While items E4 and E5 had acceptable loadings above 0.50, they exhibited significant cross-loadings with other components. Additionally, six items—C4, C6, D7, D8, G6, and J2—fell below the 0.50 cutoff and were excluded due to weak factor loadings. Despite these eliminations, and given the relatively small sample size, the factor solution in Table 6 is considered a reasonably adequate—though not perfect—fit to the data.

The rotated factor structure largely aligned with the expected constructs. For example, items C1–C5 loaded strongly on Component 1, representing Basic Digital Skills. Items D1–D6 loaded on Component 2 (Didactic ICT-Competence). Items E1–E4 and F1–F4 loaded on Components 3 and 4, corresponding to Learning Strategies and Digital Bildung, respectively. Items G1–G5 loaded on

Component 5 (Professional Development), H1–H4 on Component 6 (Organizational Infrastructure), I1–I4 on Component 7 (Strategic Leadership), and J1–J5 on Component 8 (Pedagogical Digital Competence). A few items (e.g., C4, D7, E5, etc.) that did not load clearly on their intended factor were dropped from subsequent analyses.

Table 6. Rotated component matrix

Component	1	2	3	4	5	6	7	8
C1	0.642	0.131	0.252	−0.009	0.041	0.069	0.023	−0.094
C2	0.716	0.143	−0.054	−0.046	0.112	0.069	−0.137	−0.028
C3	0.716	0.203	−0.087	0.138	0.137	0.093	−0.257	0.185
C4	0.044	0.286	0.199	0.046	0.090	0.020	0.105	0.777
C5	0.717	0.276	−0.078	0.196	0.076	−0.121	−0.208	0.104
C6	0.066	0.141	−0.014	0.272	0.510	−0.005	0.134	0.256
D1	0.160	0.852	0.100	0.056	−0.018	0.004	−0.065	0.113
D2	0.163	0.819	0.154	0.125	0.025	0.043	0.095	0.057
D3	0.074	0.815	0.106	0.074	0.143	0.059	0.156	−0.085
D4	0.136	0.837	0.062	0.030	0.130	0.088	0.154	0.029
D5	0.112	0.798	0.176	−0.015	0.108	0.143	0.248	0.018
D6	0.273	0.756	0.015	0.151	0.082	0.145	0.131	0.046
D7	0.462	0.065	0.177	0.203	0.296	0.121	0.356	0.256
D8	0.072	0.142	0.324	0.088	0.176	0.130	0.027	−0.150
E1	−0.027	0.218	0.609	0.112	0.025	0.528	−0.042	−0.005
E2	0.120	0.144	0.754	0.039	−0.016	0.285	0.086	0.028
E3	0.133	0.105	0.525	0.089	0.069	0.672	0.171	0.083
E4	0.637	0.136	0.015	0.131	0.023	0.644	0.072	0.101
E5	0.547	0.163	0.007	0.092	0.040	0.700	0.085	−0.024
F1	0.050	0.072	0.151	0.767	0.261	−0.016	0.080	0.125
F2	0.172	0.252	0.142	0.722	0.131	0.108	−0.020	0.237
F3	0.122	0.553	0.065	0.599	0.000	−0.032	0.043	−0.053
F4	0.149	0.377	0.114	0.706	0.047	−0.026	0.216	0.065
F5	−0.014	0.482	0.233	0.541	−0.106	0.075	−0.119	−0.165
G1	0.109	0.130	0.319	0.079	0.702	0.129	−0.129	0.129
G2	0.287	0.098	0.136	0.115	0.759	0.093	−0.044	0.181
G3	0.205	0.217	0.124	0.112	0.695	0.086	0.081	0.229
G4	0.163	0.111	0.062	0.039	0.593	0.218	0.410	−0.103
G5	0.189	0.003	0.043	0.089	0.663	0.080	0.534	0.149
G6	0.284	0.408	0.157	0.119	−0.001	0.148	0.588	0.164
H1	0.112	0.139	−0.006	0.198	0.024	0.716	0.011	0.084
H2	0.193	0.136	0.088	0.250	0.002	0.691	0.129	0.068
H3	0.141	−0.047	0.044	0.334	−0.006	0.667	0.197	−0.121
H4	0.173	−0.254	0.243	0.189	0.211	0.602	0.072	0.013
I1	0.117	0.260	0.187	−0.032	0.097	−0.008	0.786	−0.030
I2	0.146	0.296	0.067	0.052	0.025	0.207	0.785	0.116
I3	0.192	0.127	0.361	0.178	0.179	−0.099	0.617	−0.087
I4	0.165	0.292	0.096	−0.002	0.115	0.135	0.804	0.104
J1	0.258	0.398	0.154	0.043	0.028	0.163	−0.026	0.547
J2	0.189	0.163	0.214	0.301	0.706	−0.093	0.089	0.072
J3	0.063	0.074	0.384	0.148	0.090	0.131	−0.024	0.583
J4	0.191	−0.063	0.208	0.279	0.290	−0.070	0.150	0.622
J5	0.239	0.071	0.270	0.008	0.135	−0.038	0.020	0.751

Note: Factor loadings > 0.50 are in boldface. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 8 iterations. Item codes C through J represent questionnaire items from each construct (C = Basic Digital Skills, D = Didactic ICT-Competence, E = Learning Strategies, F = Digital Bildung, G = Professional Development, H = Organizational Infrastructure, I = Strategic Leadership, J = Pedagogical Digital Competence).

G. Reliability Analysis

To evaluate the reliability of the data, it is crucial to determine the consistency with which the items represent their respective constructs [37]. In this study, Cronbach's alpha (α) was employed to assess the internal consistency of the eight core variables. As shown in Table 7, the alpha coefficients ranged from 0.754 to 0.935, indicating a strong degree of reliability across all measured constructs.

Table 7. Summary of reliability analysis

Variable	No. of item	Cronbach's Alpha
Professional Development	4	0.754
Organizational Infrastructures	6	0.935
Strategic Leadership	3	0.844
Basic Digital Skills	5	0.833
Didactic ICT Competence	5	0.863
Learning Strategies	4	0.820
Digital *Bildung*	4	0.868
Pedagogical Digital Competence	4	0.803

H. Correlation Analysis

Table 8. Pearson correlation

Variable	R	Sig.
Professional Development	0.450	0.000
Organizational Infrastructures	0.443	0.000
Strategic Leadership	0.406	0.000
Basic Digital Skills	0.698	0.000
Didactic ICT Competence	0.824	0.000
Learning Strategies	0.767	0.000
Digital *Bildung*	0.518	0.000

Note. Significant levels: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.
(Dependent Variable: Pedagogical Digital Competence)

Prior to hypothesis testing, Pearson's correlation coefficient (r) was computed to explore the bivariate relationships between each independent variable and the dependent variable, Pedagogical Digital Competence (PDC). This analysis served as a preliminary step to identify significant correlations between the dimensions of interest. Table 8 shows the summary of the two-tailed Pearson correlations between each independent construct and PDC.

Based on Hair *et al.*'s [37] guidelines, Pedagogical Digital Competence (PDC) demonstrated a strong positive correlation with Didactic ICT Competence ($r = 0.824$, $p < 0.001$), Learning Strategies ($r = 0.767$, $p < 0.001$), and Basic Digital Skills ($r = 0.698$, $p < 0.001$). A moderate positive correlation was observed between PDC and Digital Bildung ($r = 0.518$, $p < 0.001$). Regarding organizational variables, moderate correlations were also identified with Professional Development ($r = 0.450$, $p < 0.001$), Organizational Infrastructure ($r = 0.443$, $p < 0.001$), and Strategic Leadership ($r = 0.406$, $p < 0.001$). Collectively, these findings indicate that all independent variables were positively related to PDC, offering preliminary empirical support for the hypothesized associations.

I. Linear Regression Analysis

To evaluate the proposed hypotheses, regression analyses were performed. Initially, a set of simple linear regressions was conducted to assess the individual impact of each independent construct on Pedagogical Digital Competence (PDC), corresponding to hypotheses H1 through H7. Subsequently, two multiple regression models were tested: the first examined the combined influence of the Teacher's Digital Competence Model constructs—Basic Digital Skills, Didactic ICT Competence, Learning Strategies, and Digital Bildung—on PDC; the second evaluated the collective effect of the E-Capacity Model constructs—Professional Development, Organizational Infrastructure, and Strategic Leadership—on PDC as shown in Table 9.

Table 9. Linear regression analysis

Hypothesis	Variables	R^2	Unstandardized coefficient B	F	Sig
H_1	Basic Digital Skills	0.487	4.968	219.150	0.000
H_2	Didactic ICT Competence	0.679	4.907	488.522	0.000
H_3	Learning Strategies	0.588	7.969	329.237	0.000
H_4	Digital *Bildung*	0.268	9.865	84.632	0.000
H_6	Professional Development	0.202	10.048	58.641	0.000
H_7	Organizational Infrastructures	0.196	12.693	56.398	0.000
H_8	Strategic Leadership	0.164	13.926	45.471	0.000

Note: Significant levels: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$ All models were significant ($p < 0.001$). Each row represents a separate simple regression of the independent variable on PDC.

J. Multiple Linear Regression Analysis

In this study, the multiple linear regression relationship between (1) Teacher's Digital Competence Model (consist of Basic Digital Skills, Didactic ICT Competence, Learning Strategies and Digital Bildung) with Pedagogical Digital Competence, and (2) E-Capacity Model (consist of Professional Development, Organizational Infrastructures, and Strategic Leadership) with Pedagogical Digital Competence was tested. Table 10 provides the results related to the analysis of the multiple linear regression.

As shown in Table 10, multiple linear regression was conducted to investigate the relationship between the E-Capacity Model—comprising Professional Development, Organizational Infrastructures, and Strategic Leadership—and Pedagogical Digital Competence (PDC). The model, including all three predictors, yielded an R^2 value of 0.379, $F(1, 229) = 46.490$, $p < 0.001$, indicating a statistically significant overall model fit. Among the predictors, Professional Development demonstrated a positive and significant association with PDC, suggesting that higher levels of professional development correspond with greater pedagogical digital competence, even after accounting for the effects of the other variables. The two other variables (Organizational Infrastructures and Strategic Leadership) scores were found to be lower with insignificant $p > 0.05$ indicating those ESL lecturers were expected to have lower and insignificant Pedagogical Digital Competence. Even though all three predictors produced different scores, E-Capacity Model somehow contributed to a significant relationship with Pedagogical Digital Competence through multiple linear regression model.

Table 10. Multiple linear regression analysis

Hypothesis	Variables	R^2	Unstandardized coefficient B	F	Sig
H_5	Teacher's Digital Competence Model	0.731	5.151	154.731	0.000
	Basic Digital Skills		0.233		0.000
	Didactic ICT Competence		0.277		0.000
	Learning Strategies		0.203		0.000
	Digital Bildung		0.092		0.022
H_9	E-Capacity Model	0.379	9.301	46.490	0.000
	Professional Development		0.426		0.000
	Organizational Infrastructures		0.055		0.159
	Strategic Leadership		0.031		0.516

Note: a. Dependent Variable: Pedagogical Digital Competence
Significant levels: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

The findings for H9 indicate that higher levels of E-Capacity are associated with increased levels of Pedagogical Digital Competence. Based on the finding, the pedagogical aspects of digital competence comprehensively involve the capabilities of lecturers as well as the university. Similarly, accommodating organizational infrastructures, development of policies, and implementation of strategic leadership are comprehensively integral in realistically attaining the established goals through the teaching practice of lecturers, ensuring the necessary technological integration, and improving lecturers' overall digital proficiency. Within educational settings, the concept of digital competence remains multifaceted, encompassing intricate requirements for both its development and assessment. This is in evidence with the insignificant result for organizational infrastructures and strategic leadership p values in this study.

In view of strategic leadership, the university management and leadership should embrace the application of digital technologies and incorporate these technologies as part of professional development to attain digital competence. Whereas, on organizational infrastructures, the university should emphasize supportive school culture and demonstrate that such culture is necessary to prompt the university leadership as well as lecturers to explore ICT-based teaching approaches. Based on the above explanation and the overall result of E-Capacity, H9 is accepted.

K. Summary of Hypothesis Testing

Drawing from the outcomes of the multivariate analyses, Table 11 provides a consolidated summary of the hypothesis testing results presented in this chapter.

Table 11. Summary of hypotheses testing

No	Hypothesis	Result
H_1	Basic Digital Skills has a significant relationship with Pedagogical Digital Competence.	Supported
H_2	Didactic ICT Competence has a significant relationship with Pedagogical Digital Competence.	Supported
H_3	Learning Strategies has a significant relationship with Pedagogical Digital Competence.	Supported
H_4	Digital Bildung has a significant relationship with Pedagogical Digital Competence.	Supported
H_5	Teacher's Digital Competence Model has a significant relationship with Pedagogical Digital Competence.	Supported
H_6	Professional Development has a significant relationship with Pedagogical Digital Competence.	Supported
H_7	Organizational Infrastructures has a significant relationship with Pedagogical Digital Competence.	Supported
H_8	Strategic Leadership has a significant relationship with Pedagogical Digital Competence.	Supported
H_9	E-Capacity Model has a significant relationship with Pedagogical Digital Competence.	Supported

All hypotheses H_1–H_9 were supported by the analyses. It is noted that H_5 and H_9, regarding the combined models, were supported in terms of overall model significance. However, within H9's multiple regression, two components (organizational infrastructure and strategic leadership) did not individually show significance as predictors, despite the E-Capacity model as a whole being significantly related to PDC.

V. Discussion

The first research question aimed to explore the relationship between ESL lecturers' digital competence—comprising basic digital skills, didactic ICT competence, learning strategies, and digital Bildung—and their Pedagogical Digital Competence (PDC). The analysis yielded several key insights. Linear regression results indicated a significant positive association between these variables and PDC, suggesting that ESL lecturers generally view their digital competence as a critical component of effective teaching. These findings align with the broader shifts occurring in higher education, where digital integration reflects global educational trends and evolving societal demands. The meaningful use of ICT in instructional settings increasingly relies on lecturers having sufficient digital skills to seamlessly embed technology into their pedagogy.

The multiple linear regression analysis highlighted a clear distinction between the digital competence of lecturers and that of general technology users. While general users may focus primarily on operational or technical skills, lecturers' digital competence encompasses pedagogical strategies that support effective teaching and learning within digital environments. The findings also suggest that a lecturer's confidence in achieving instructional goals and meeting performance expectations plays a key role in effectively applying digital skills in the classroom. Digital literacy, therefore, extends beyond basic technological proficiency. It encompasses a wide range of competencies, including cognitive, physical, social, and emotional skills, all of which are essential for effective engagement in digital environments [4].

The findings of this study are consistent with two dominant perspectives in the existing body of literature. The first, advocated by scholars such as Ferrari [38], Janssen *et al.* [39], Krumsvik [12], Røkenes and Krumsvik [19], and Krumsvik *et al.* [11], asserts that digital competence is grounded in four fundamental domains: basic digital skills, didactic use of ICT, learning strategies, and digital Bildung. These studies further underscore the importance of access to technological tools as a prerequisite for the effective integration of ICT into teaching practices. Conversely, a contrasting position is supported by Al Khateeb [40], Elstad and Christophersen [41], and Guillén-Gámez *et al.* [42], who argue that a substantial number of lecturers still lack the necessary digital competencies to meet the demands of contemporary educational settings. This perspective is echoed by Zhao *et al.* [43] and Instefjord and Munthe [21], who stress that digital literacy extends beyond technical know-how to include pedagogical alignment and social awareness. This confirmed that PDC is based on the pedagogical compatibility areas and not on the technological competence. The study specifically recommends institutional actions like developing targeted ICT training programs, offering incentives (e.g., grants or recognition) for innovative digital teaching, and facilitating communities of practice among ESL lecturers to encourage peer-learning and mentorship in technology use. These practical measures have the potential to equip lecturers with the necessary skills and confidence to integrate technology more effectively into their instructional practices.

In summary, as digital skills become more embedded within the education system, the demand for lecturers who possess both the knowledge and the ability to effectively apply these tools in their teaching practices is increasingly evident. The results of this study indicate that ESL lecturers are professionally equipped to utilize digital technologies in a manner that effectively supports their pedagogical objectives. Their ability to manage the pedagogical use of technology within classroom settings has been clearly demonstrated. This research contributes to filling a gap by exploring how ESL lecturers in Malaysia apply digital literacy within the framework of pedagogical digital competence.

The second research question aimed to investigate the relationship between the components of the E-Capacity Model—namely professional development, organizational infrastructure, and strategic leadership—and ESL lecturers' Pedagogical Digital Competence (PDC). The linear regression analysis revealed a significant positive association, indicating that these organizational factors collectively contribute to the enhancement of PDC among ESL lecturers. However, the multiple regression analysis in Table 10 shows two of the E-capacity model's construct (organizational infrastructures and strategic leadership) have an insignificant association with PDC even though the overall model's result in multiple regression addressed to be significant with PDC.

The findings indicate that the development of pedagogical digital competence is influenced not only by individual lecturer capabilities but also by the level of institutional support provided. Effective integration of ICT in teaching and learning is more likely to occur when educators adopt innovative, student-centered pedagogical approaches [44]. To support these approaches effectively, institutions must invest in professional development, maintain supportive infrastructure, and foster strong leadership that encourages the integration of digital practices. This is consistent with recent research on Malaysian ESL teachers' technology adoption, which found that facilitating conditions—such as the availability of technology or institutional support—had a limited influence on lecturers' intentions to use technology, compared to personal factors like perceived usefulness and ease of use [45]. Similarly, the findings of this study demonstrate that, although organizational infrastructure and strategic leadership showed no significant association with PDC in the multiple regression analysis, meaningful progress toward achieving pedagogical goals and integrating technology effectively was still evident through the lecturers' teaching practices.

Despite a few unanticipated results, the overall findings concerning the E-Capacity Model align with those reported in prior studies by Vanderlinde and van Braak [26], Wastiau [9], From [3], and van Schaik *et al*. [46]. The results also closely resemble those reported by Petterson [47], particularly given the comparable focus on pedagogical digital competence. Although attention has been growing to digital skills in educational environments, limited research addresses how these skills relate to institutional infrastructure and strategic leadership. This pattern may reflect contextual or measurement issues, where the personal digital competence of lecturers plays a more significant role than institutional factors in influencing outcomes [45]. It also suggests that many studies concentrate on individual capabilities while overlooking broader structural or social influences within higher education institutions.

The analysis further underscores the need to embed digital skill development within lecturer training programs—an emphasis echoed in earlier research [11, 12, 48–50]. For instance, Røkenes and Krumsvik [19] examined how educators develop technical competencies and outlined effective strategies for equipping future teachers to integrate technology into their instructional practices. Their findings stress the need for a comprehensive approach that includes both conceptual understanding and practical application. Additionally, Tømte and colleagues [50] examined how lecturers can model digital practices, showing that their own engagement with technology positively influences students' digital development.

While the findings underscore the significance of institutional factors—such as infrastructure, professional development, and leadership—in fostering digital competence, much of the existing literature continues to place emphasis on the role of individual lecturers. Educators are frequently expected to independently plan, manage, and deliver technology-integrated instruction, often assuming personal responsibility for acquiring the technical skills needed to support students in digital learning environments. However, Madsen *et al*. [51] argue that digital competence should be viewed as a collective responsibility embedded within the broader university structure. Despite this perspective, there remains limited understanding of how institutional frameworks and leadership dynamics contribute to effective digital integration. Most studies tend to prioritize individual skills while paying less attention to the broader conditions within universities. This gap in research makes it difficult to fully grasp how change and development in digital teaching practices occur. This study contributes to addressing that gap by exploring pedagogical digital competence among ESL lecturers within the E-capacity framework in Malaysian higher education.

In terms of implications, this study makes several meaningful contributions to the field of pedagogical digital competence, especially within the context of ESL lecturers. Theoretically, it draws upon Krumsvik's model from 2014 and the E-capacity framework to assess how ESL educators develop and apply digital teaching skills. The integration of both models demonstrates how these frameworks can be adapted to study other groups, including lecturers, tutors, and university students. In terms of pedagogical theory, the study aligns with the TPACK model, emphasizing that ESL lecturers must critically consider what, how, and why they implement digital tools in their teaching. This reflective process, described by Schön [52] as "reflection-on-action", is central to building competence in digital pedagogy.

Empirical findings from the E-capacity model further illustrate the need for institutions to foster sustainable practices among lecturers that support meaningful change through digital innovation. Two core elements emerged from this framework: institutional readiness and the professional capacity of educators While numerous Malaysian studies have predominantly employed established frameworks like TPCK [25] and DIGCOMP [49, 50], the present research demonstrates the applicability and relevance of Krumsvik's Digital Competence Model and the E-Capacity Model for examining digital competence within the specific context of Malaysian higher education and ESL instruction. These models also align closely with national educational priorities, such as those articulated in the Malaysia Education Blueprint 2013–2025, which advocates for the development of digital skills, pedagogical knowledge, and comprehensive educator competencies. One of the strengths of this study lies in its attention to factors such as professional development, institutional support, and leadership practices. These elements are essential for advancing digital competence across the ESL teaching profession. In conclusion, the study calls for greater awareness among ESL educators about how they can use ICT in pedagogically sound and meaningful ways, contributing valuable insights into how digital skills can be integrated into English language teaching.

Although this study offers important insights, it is not without limitations, which also suggest directions for future research. The investigation focused primarily on constructs outlined in Krumsvik's model and the E-capacity framework, while including a few additional variables identified in related literature on digital competence and pedagogical digital competence. However, other potential factors may also play a significant role. These could include how digital technologies are perceived, their practical value in the classroom, and the extent to which they shape instructional practices. Future research is encouraged to investigate these factors, along with additional variables, to gain more comprehensive insights into the underlying drivers of digital competence adoption and implementation among ESL lecturers.

VI. Conclusion

In conclusion, this study successfully achieved its primary aims by investigating the development of digital competence among ESL lecturers and examining the integration of ICT into their instructional practices. It contributes to the expanding body of literature by emphasizing the combined influence of individual capabilities and institutional support in shaping pedagogical digital competence. The findings offer valuable insights into how ESL lecturers strengthen their digital skills and apply them effectively in classroom settings. More broadly, pedagogical digital competence extends beyond mere technological proficiency—it also encompasses instructional strategies, subject matter expertise, learning philosophies, and the capacity to interconnect these elements in pedagogically meaningful ways. As key influencers in students' academic environments, university lecturers play an essential role in creating learning contexts that are adaptive, relevant, and digitally informed. This study recommends institutional actions such as designing targeted ICT training programs, offering incentives for digital integration in teaching, and encouraging peer learning and mentorship among ESL lecturers.

Conflict of Interest

The author declares no conflict of interest.

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